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SHOOTING A LIFE LINE TO A DISABLED SHIP—[See page 117]

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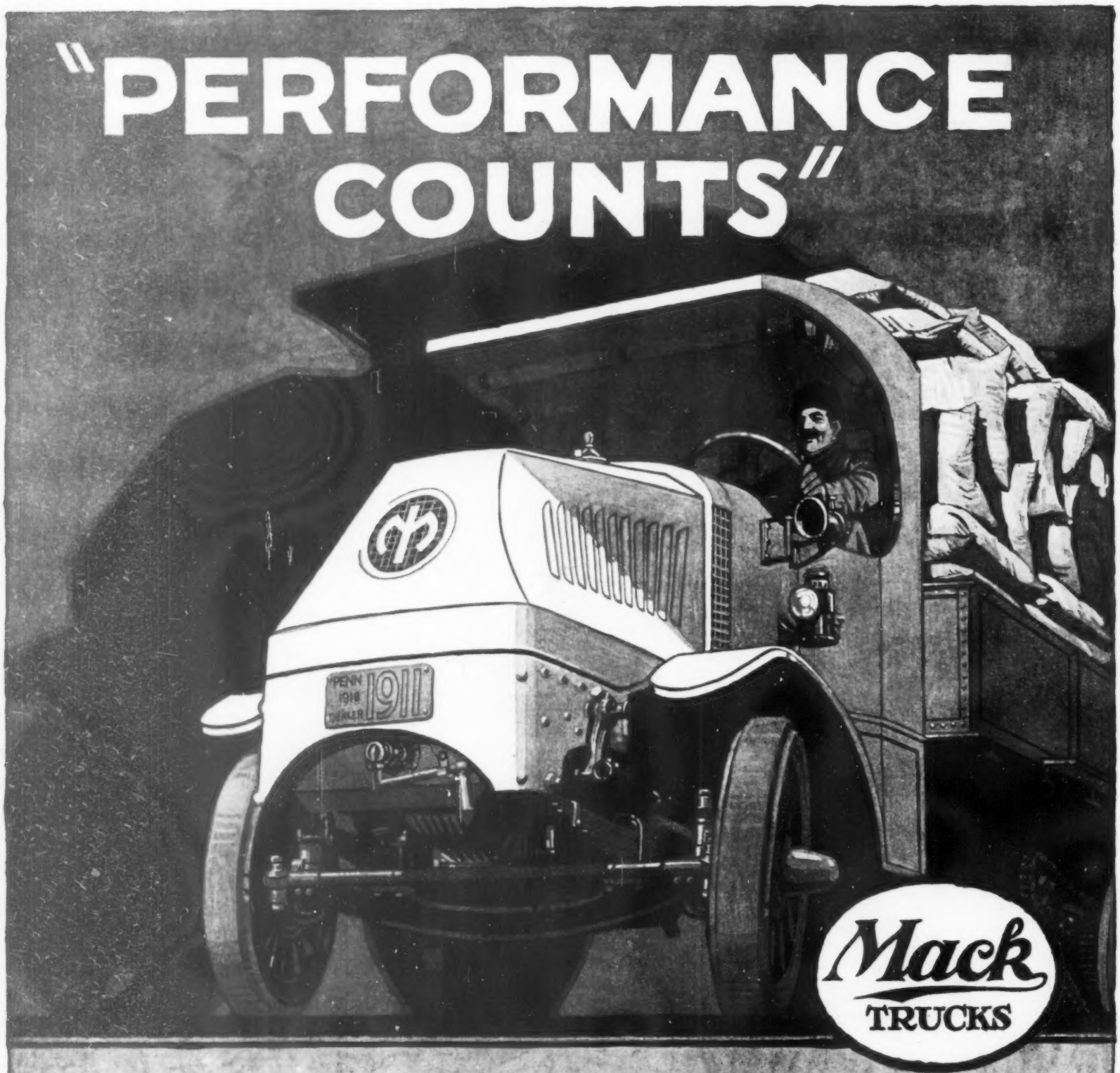
"PERFORMANCE COUNTS"



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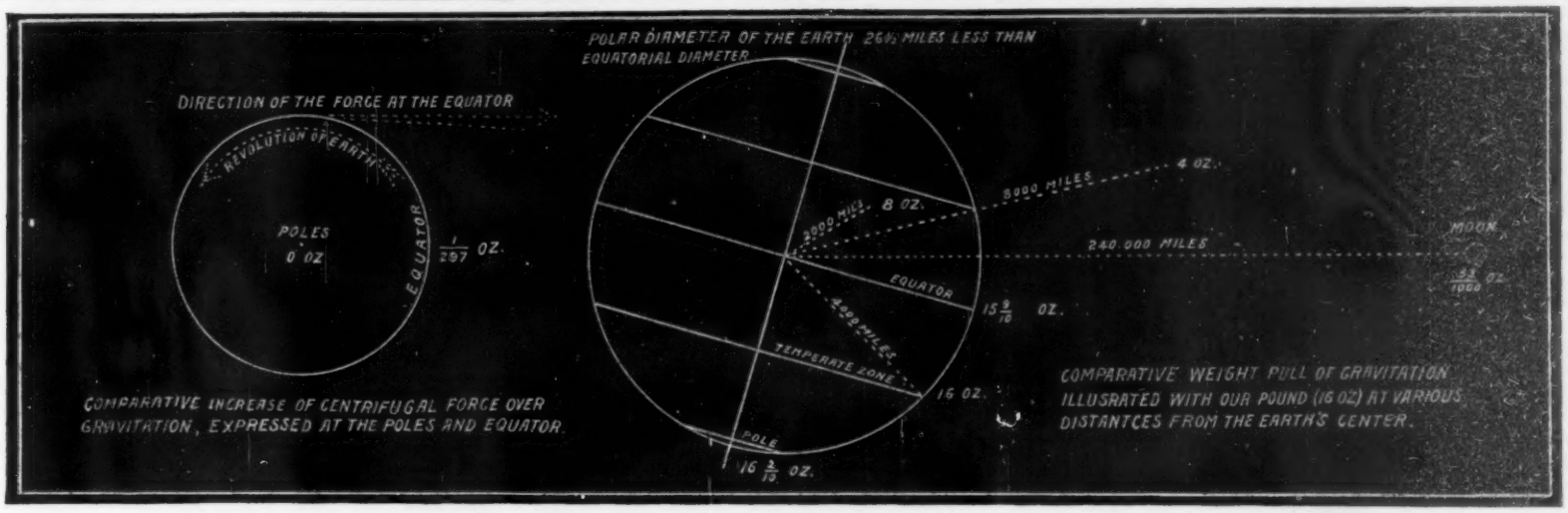

How the gravitational and centrifugal forces act on an object at various distances from the earth's center to determine its weight

Why Is It a Pound?

THERE are few who will not be surprised to hear that a pound weight is associated in a way with astronomy. What has that uninteresting science of the heavenly bodies to do with weighing of our weekly stipend of sugar? Very well, let us see what those great mysterious specks, the sun, moon, planets and stars have to do with sixteen ounces of Cuban Best.

In the first place, we are compelled to state that there are different kinds of pounds, as pounds Troy (which contain 12 ounces), pounds avoirdupois, containing 16 ounces), and so on; whatever the kind, however, it will be found that all are controlled by the same set of natural laws, and for convenience and a clearer understanding of our subject we shall take but one kind, the common 16-ounce avoirdupois pound that the grocer uses. The method of correcting a pound weight is easy enough, and you, gentle reader, can try it if you are not satisfied with the general results of your merchants' scales. All that you have to do is to take a cubic inch of distilled water at a temperature of 62° Fahrenheit, first being sure that the barometer is at 30 inches, when you will have 252.458 Troy grains of absolutely correct, never-changing weight. It is only a step further to work up your cubic inches to 7,000 Troy grains—the true weight of one pound avoirdupois.

It is a trifle mussy and somewhat annoying to do this, but it is simple enough as anyone can see. But why does a cubic inch of distilled water under certain conditions always weigh 252 and a fraction grains Troy? That is the question. The answer is not at all as simple as the weighing of the water, yet the observations of a young chap of twenty-four, by the name of Newton, have given us a considerable push in the right direction. The observations were commenced in 1666 with the falling of an apple from a tree, and culminated some time later in his announcement of the law of gravitation. The force that makes an object like an apple fly toward the ground, and which has for more than two centuries been known as gravitation, is responsible for the pound weight's seeking to force its 16 ounces through every obstacle, on towards the center of the earth.

The law of gravitation—"Every particle of matter in the universe attracts every other particle of matter with a force directly proportional to its mass, and decreasing as the square of its distance increases."—is understood easily when we consider that a stone falls to the ground because the earth attracts it; but the stone also attracts the earth, and the force of the attraction is in proportion to their relative masses. Each moves to meet the other, but the stone passes through as much greater distance than the earth as its mass is less. Hence, our pound weight is a definite mass attracted by another definite mass, the earth. All weights, strange as this may seem, are based on the revolution of the earth on its axis, which is the recognized standard of time. We have seen that a pound is the weight of a given bulk of distilled water, measured by cubic inches. An inch is a definite part of the length of a pendulum as it vibrates seconds in the latitude of London; and as we cannot have the given bulk of water without the inch, time does really regulate the weight. Furthermore, a pound weight that is regulated in this way is as accurate as are the movements of the planets themselves.

Gravitation is the general term applied to the attraction that exists between all bodies in the universe; gravity is used to designate the earth's attraction for terrestrial bodies, and weight is the measure of the forces of gravity. Therefore, our pound registers the amount of attraction that the earth has for this amount of substance. At the exact center of the globe it would have no weight at all, for it would be in the position where gravity was pulling it equally in all directions; on the surface it will vary in an infinitesimal degree by its location either within the depth of a deep mine or upon the top of a lofty mountain. On the mountain it will be a very small fraction lighter than in the mine, for it is a part of the law of gravitation that the weight of a body decreases as the square of its distance from the center of the earth increases. The revolution of the earth on its axis brings in another complication, that of centrifugal force, which has something to do with the variations of our pound. At the poles, for instance, it will weigh a fraction more than at the equator, for the reason that centrifugal force is slight at the earth's poles. For all general purposes, however, our true pound will be a true pound the world over.

To understand this law of gravitation more easily, let us imagine the sun attached to the earth with a cable, each star with a thread—all holding our globe in place—while we, in turn, send back a cord to each, so that we are bound to them and they to us; thus are we all bound together by cords of mutual attraction, making the universe a single unit. The force of this attraction is toward the center of the earth, and all bodies falling freely move in a direct line toward that point. This line is called the vertical, or plumb-line. Our pound weight, to function properly, must move unrestrictedly down this line. A pound of sugar or any other substance cannot be weighed correctly unless it also follows, unobstructed by any cause whatever, this vertical path of gravity. Therefore, whatever kind of scale is used for weighing, let it be a spring-scale, a showy price-computing scale, or a plain honest balance, the thing to be weighed must travel down a straight, unobstructed, perpendicular path to be weighed honestly. A correctly leveled and adjusted balance is the only reliable scale possible with the laws of gravity; then, and only then, can we use the pound weight as a measure, thus obtaining true weight governed by the stars.—*W. M. Butterfield.*

Lumber Salvage in France

A LITTLE wood goes a long way in a French house, and the large amount of wood that will be salvaged from the devastated cities will probably result in a smaller demand for American building lumber for reconstruction than was at first expected.

Although cities and towns are in ruins in the war regions, they are not pulverized and in most of them there is enough building material fit for salvage to rebuild a fair percentage of the houses. The steel is nearly always so badly twisted as to need remelting, but there is a great amount of lumber in the form of floor and roof beams, door planks, etc., that is still in excellent shape. Some which has been partly splintered may be resawed.

There is also a large amount of trench lumber; in fact, there are in the Allied and German trenches, dug-outs and other military works "billions of feet of lumber and timbers that will be used again." Practically every prominent dug-out has walls and roof and often floor of thick boards and planks, the whole braced with enormous timbers. All along the Hindenburg line and for miles in the rear of both opposing positions are great quantities of wood in the dug-outs, trenches and artillery positions. Most of this wood is in fine condition and all can be used extensively in rebuilding homes and even cities.

The French peasants have been most careful in salvaging their forests also, the sound trees and those whose wounds will heal, being left standing, the hopelessly broken trees being cut for lumber, and the rest, branches and all, being neatly piled for cordwood. Even the leaves are gathered up for fuel.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Rear-Admiral William S. Sims

WE venture the statement that there is no one man in the United States Navy who holds so high a place in the confidence and esteem of the American public as Rear-Admiral Sims. This regard is based upon his record, which has shown that, in his supreme desire to promote the efficiency of the Navy, he has never been afraid to criticise defects, even at the risk of sacrificing his own prospects of promotion.

Early in his career he became convinced that gunnery in the United States Navy had fallen to a low ebb. He wrote to the Department, stating his views and suggesting that target-practice methods which were already in use by a leading naval power and giving excellent results, be adopted. His report was pigeonholed. Subsequently, at the risk of wrecking his future career, he wrote to the President himself, who, most opportunely, had a way like Sims of cutting red tape where the vital interests of the country were concerned. President Roosevelt sent for Sims; made him his naval aide; placed him in charge of target practice; and told him to go ahead. The result was that our whole system of gunnery was reorganized, and before long we were showing target scores that compared favorably with those of the best of the foreign navies.

The same willingness to sacrifiec his own professional interests in exposing faults and abuses and promoting the efficiency of the Navy has characterized his whole career. It is the Sims "touch," and this, coupled with his great professional abilities, has won for him the highest regard of his brother officers, who believe that where the safety of the country is concerned, personal considerations should have no place in the thought or practice of the naval officer. It is his wholehearted and fearless devotion to the Navy and the country whose flag it flies, coupled with his distinguished record in the late war, that has won for him a popularity with the American people, for which we must go back to the days of Dewey to find a parallel.

On our entrance into the war, a request came from the British Government that a naval officer of high rank be sent to confer with the Allied powers as to the best means of coöperation in the naval war. Sims has recently stated in a letter to Secretary Daniels that on his departure he received only verbal orders. "No formal instructions or statement of the Navy Department's plans or policy was received at that time," he says, "though I received the following explicit admonition: 'Don't let the British pull the wool over your eyes. It is none of our business pulling their chestnuts out of the fire. We would as soon fight the British as the Germans.'"

Now here is the Sims "touch," with a vengeance; but we think that it is a thousand pities that the statement has been allowed to get into the public press, particularly just now, when a determined effort is being made by a hyphenated section of the community to break up the good feeling between this country and Great Britain. This much, however, is certain: that if the remark was made, it was a gross misrepresentation of the attitude both of the American Navy as a whole and of the American people. It is not in accordance with our principles or our practice to enter into a partnership with a smile upon our lips and an ugly distrust in our hearts. A charge like this, coming from the lips of a man of such straightforward integrity as Admiral Sims, cannot be lightly brushed aside. It should be sifted to the very bottom, first, to prove that in no sense did it represent the attitude of the American Navy and the American people, and, secondly, to secure, should the charge be proved, the most drastic punishment of any official, be his rank even of the highest, if he should be proved guilty of expressing a sentiment which is at once an offense to our own good name and to that of a great ally.

The letter of Admiral Sims was written in reply to a request sent out broadcast to naval officers, asking them to make suggestions, based on their war experience, which might be of assistance in determining future naval policy and practice. It was read at a meeting of the Senate Naval Committee called to investigate the question of the award of naval medals. Admiral Sims had sent in a list of awards based upon the service of the officers who worked under him in Europe. Mr. Daniels had substituted a list of his own. In that list the Secretary proposes to establish the extraordinary precedent of awarding Distinguished Service Medals to officers who have lost their ships. Among the recipients of this amazing grant he places his own brother-in-law, whose destroyer was sunk by a random torpedo, fired at a distance of over two miles by a German submarine. There was one chance in a thousand that this particular ship would be hit, and that this accidental happening should be made the occasion of hanging a Distinguished Service Medal upon the breast of the officer who happened to be in command is so obviously absurd, that the Secretary's brother-in-law has done the only possible thing for him to do, as an officer and a gentleman, and refused the decoration. This grotesque incident will be recognized, the country over, as a characteristic Daniels "touch."

The charges of lack of support and positive obstruction of the Nation's chosen representative in Europe is summed up in eleven separate counts, of which the outstanding charge is that for four months at the critical period of the war, when Germany seemed to be winning through her submarine campaign, the Department refused to provide the Admiral with more than one aide (Pershing took over a staff of forty-three, which was enlarged to 1,500), and this in spite of his frantic appeals for assistance. He asked that every possible type of warship available for submarine warfare be despatched—after much delay he got six destroyers. Through him, the British Admiralty asked that a squadron of battleships be rushed over to guard the Channel exit from the North Sea; "No reply" says Admiral Sims, "was made to this suggestion," and the ships were sent only after many months of delay.

To have the matter on record, we append the indictment in full:

"1. Although war with Germany had been imminent for many months prior to its declaration there was nevertheless no mature plan developed or naval policy adopted in preparation for war in so far as its Commander in Europe was informed.

"2. The Navy Department did not announce a policy until three months after war was declared—at least not to its representative and the Commander of the forces in Europe.

"3. The Navy Department did not enter wholeheartedly into the campaign for many months after we declared war, thus putting a great strain upon the morale of the fighting forces in the war area by decreasing their confidence in their leaders.

"4. The outbreak of hostilities found many important naval units widely dispersed and in need of repairs before they could be sent to the critical area. Destroyers arriving in the war zone had been cruising extensively on our seaboard and in the Caribbean, and when war was declared were rushed through a brief and inadequate preparation for distant service.

"5. During the most critical months of the enemy's submarine campaign against the Allied lines of communication the department violated the fundamental strategical principle of concentration of a maximum force in the critical area of the conflict.

"6. The department's representative with the Allied admiralty was not supported during the most critical months of the war either by adequate personnel or by the adequate forces that could have been supplied.

"7. The department's commander in the critical area of hostilities was never allowed to select his principal subordinates and was not even consulted as to their assignment. A fundamental principle of the art of command is here involved.

"8. The Navy Department made and acted upon decisions concerning operations that were being conducted 3,000 miles away, when the conditions were such that full information could not have been in its possession, thus violating an essential precedent of warfare that sound decision necessarily depends upon complete information.

"9. Instead of relying upon the judgment of those who had actual war experience in this peculiar warfare, the Navy Department, though lacking not only this experience but also lacking adequate information concerning it, insisted upon a number of plans that could not be carried out.

"10. Many of the department's actions so strongly implied a conviction that it was most competent to make decisions concerning operations within the war zone that the result was an impression that it lacked confidence in the judgment of its representative on the council of the Allies and its responsible commander in the field. It is a fundamental principle that every action on the part of superior authorities should indicate confidence in subordinates. If such confidence is lacking it should be immediately restored by ruthlessly changing the subordinate.

"11. 'To interfere with the commander in the field or afloat is one of the most common temptations of the Government, and is generally disastrous.'—The Influence of Sea Power Upon History.—Mahan."

The Navy Department did not resist this temptation and its frequent violation of this principle was the most dangerous error committed during the naval war.

Freight Should Seek the Barge Canal

DESPITE the obstacles that have been encountered in the effort to rehabilitate commerce on the canals, New York State canal authorities are not discouraged, and they face the tremendous task of restoring business to the waterways with the same energy and optimism as characterized the work of construction. During the fifteen-year period of canal reconstruction, the majority of shippers sought other means of transportation and when the new waterway was opened, it was found the average merchant and manufacturer had little, if any, conception of the merits or economies of inland water transportation. The state accordingly set out on a campaign of education. Literature descriptive of the canal system was sent broadcast throughout the entire Atlantic Seaboard and into the Middle West. The rates, schedules and facilities of canal carriers have been extensively advertised and brought to the attention of shippers by personal solicitation. In order that shippers might see at first hand the splendid facilities the waterway offered and be convinced of the excellence of the service, parties were conducted over the system from time to time and shown the working of the mammoth locks and the equipment of the terminals. Prejudices against canal transportation, born largely of ignorance of true conditions, were overcome in this manner and the fruits of such educational work are to be seen in the increased tonnage of 1919. While many hundreds of shippers have been interviewed and have had an opportunity of inspecting the waterway, and although the state will continue its work along these lines, it was seen that years of effort would be required before the thousands throughtout New York, New England and the Middle West could be reached and converted. Therefore, the entire canal system was photographed and an unusually fine moving picture of the waterway was recently completed. It is now planned to exhibit this picture throughout the canal territory and to actually bring the canal to those who, because of their location or disinterest, had not seen it themselves.

Naval and Military

Some Naval War Figures.—The magnitude of the operations carried on by the British fleet during the war has been indicated by the recently published expenditures during the four years of the conflict. In the year 1915-16, the expenditure was $1,028,500,000; in 1916-17, it was $1,049,250,000; in 1917-18, it was $1,136,850,000; in 1918-19, it rose to $1,625,000,000, and at the time of the armistice in November, 1918, the naval expenses were running at the rate of $33,750,000 a week, or at the rate of one and three-quarters billions of dollars a year.

Dearth of Continental Warship Building.—The latest advices show that the five new French battleships of the "Normandy" class stand about where they were at the time of the armistice. At first there was some talk of completing four out of the five, but, according to advices from Paris, their completion has been postponed for the present. Italy, moreover, seems to have abandoned the idea of completing the four so-called "super-dreadnoughts" authorized in 1914—there is even some talk of their being converted into merchant liners. The press of Rome says that the ships were abandoned when it was learned that it would cost some $30,000,000 each to complete them.

The Japanese Invasion Bogey.—The frequently and foolishly talked of possibility of a Japanese raid on our Pacific coast is nothing less than silly. For invasion, a vast fleet of transports must be ready. No country maintains transports for such service; liners and commercial ships must be withdrawn and converted for transport use. Such withdrawal would be known immediately the world over, and the length of time necessary in getting the transports ready for service would give ample time to prevent any threatened invasion. Moreover, should troops by any chance be landed, the enormous preponderance of our fleet would cut the line of communications with Japan. It is an established principle that no nation will trust its troops at sea until the control of the sea has been established.

Naval Bases on the Atlantic Seaboard.—The following, briefly, are good reasons why the principal bases for the American Navy have been developed along the Atlantic Seaboard. First, American interests on this coast are much greater than on any other. Here are our largest cities and principal industries. Second, most of the American shipping is in the Atlantic, and there most of the Navy should be based. Third, the Monroe Doctrine aims to prevent European colonization in North or South America, and the approach to the Western Hemisphere must be made by way of the Atlantic. Fourth, because of the denser population on the Atlantic Seaboard, it is advisable that the bulk of our ships should be based on Atlantic ports. Moreover the men are more content when their ship's base is convenient to their homes, a most important factor in morale and efficiency. Fifth, skilled artisans, supplies of material and the great manufacturing plants are nearer the Atlantic than the Pacific Seaboard, and on this coast, therefore, the cost of repairs and coal is considerably less.

From War to Peace in Navy Yards.—It takes time to readjust such a vast industry as that of naval warship construction from a war to a peace basis. A large amount of scrapping of warships that were on the building ways and partially completed has to be done. This takes only less time than their construction. Also, the governments that were at war are still using a large amount of warships and commercial vessels for meeting certain requirements and commitments in the various centers of conflict. A great amount of labor and time have been consumed in retransforming commercial ships from war-time to peace-time service. In some cases, notably in Great Britain, as soon as the naval shipbuilding ways are vacated, commercial ships have been laid down and many of these are well under way. Incidentally, it is interesting to note our contemporary, *The Shipping World*, is of the opinion that already there is more shipping afloat in the world than there was five years ago, and this notwithstanding the grievous losses due to war. On the other hand, the necessities of nations are greater today than they were in 1914, and hence a larger contingent is required to meet them.

Science

Postal Atlas of China.—An excellent atlas of China, showing the location of all postoffices and post routes and indicating the distances between the various postoffices and the frequency of mail deliveries has recently been published by the Chinese Postoffice Department. It was intended primarily for official use in China, but a limited number of copies is on sale at $12 a copy at the main Chinese postoffice in Peking.

Bottom Sampler for Marine Biologists.—*Science* states that persons interested in the study of bottom fauna may now obtain, made to order in the United States, a quantitative bottom-sampler as used by Peterson in his recent work at the Danish Biological Station. The address of the firm which builds these machines can be obtained from the Illinois State Natural History Survey, Urbana, Ill. The Illinois Biological Station is already using one of the machines.

Uniformity in Chemical Nomenclature.—As a step toward securing uniformity in the chemical vocabulary of English-speaking countries, the American Chemical Society has invited the governing bodies of the Chemical Society (London) and the Society of Chemical Industry to appoint a committee, or committees, on nomenclature, spelling and pronunciation to coöperate with the corresponding committee of the American Chemical Society, in order to secure as large a measure of agreement in these fields as is practical.

Testing Natural Gas for Helium.—One evidence that the Government is continuing the novel enterprise, begun during the war, of extracting helium on a large scale from certain grades of natural gas is an announcement from the Bureau of Standards that apparatus for continuously recording the percentage of helium in a gas mixture has been designed, by the Bureau and installed at Petrolia, Texas. Analyses of the gas used at the helium plant are frequently required, in order to control the operations, and such analyses, when made by the older methods, require so long a time that the operating conditions they represent may have changed entirely before the results of the analysis are available. The new recorder gives a continuous record, which is always up to date.

"Transhumance" in America.—In parts of Europe it has been the practice for centuries to transfer herds of cattle from the lowlands to mountain pastures in spring and to bring them back to the plains at the approach of winter. The journey is often performed by railway. This practice, known in French as *transhumance*, has found an interesting parallel this year in the western United States. Owing to severe drought in Montana and parts of Wyoming and the Dakotas and the consequent failure of feed crops and pastures, arrangements have been made, under the auspices of the U. S. Department of Agriculture, for shipping hundreds of thousands of head of cattle and sheep to other states, and eventually returning those not sold at destination. Special transportation rates have been established by the railroads to facilitate this enterprise.

Mortality Statistics of Wage Earners.—The Metropolitan Life Insurance Company has published a book giving an extremely valuable analysis of the 635,449 deaths that occurred among its policyholders of the industrial classes during the years 1911 to 1916. The area covered by the data includes the whole of the United States and Canada, and is therefore much greater than the registration area of the U. S. Census. The data are classified according to color, age and sex, and bring out a great many interesting facts concerning prevalence of various causes of death, expectations of life, etc., with comparisons between the wage-earning class, as represented by the insured, and the population at large, as represented by census statistics. It is notable that accidents rank fifth among the causes of death. The accident mortality for the ages from 35 to 45 was 154.3 per 10,000 in the insured males, and 139.6 per 10,000 in the males of the same ages as tabulated by the Census Bureau for the registration area. The corresponding figure for England and Wales in 1913 (*i. e.*, before the war) was only 62.4 per 10,000—an evidence of the urgency of the "safety first" campaign in America.

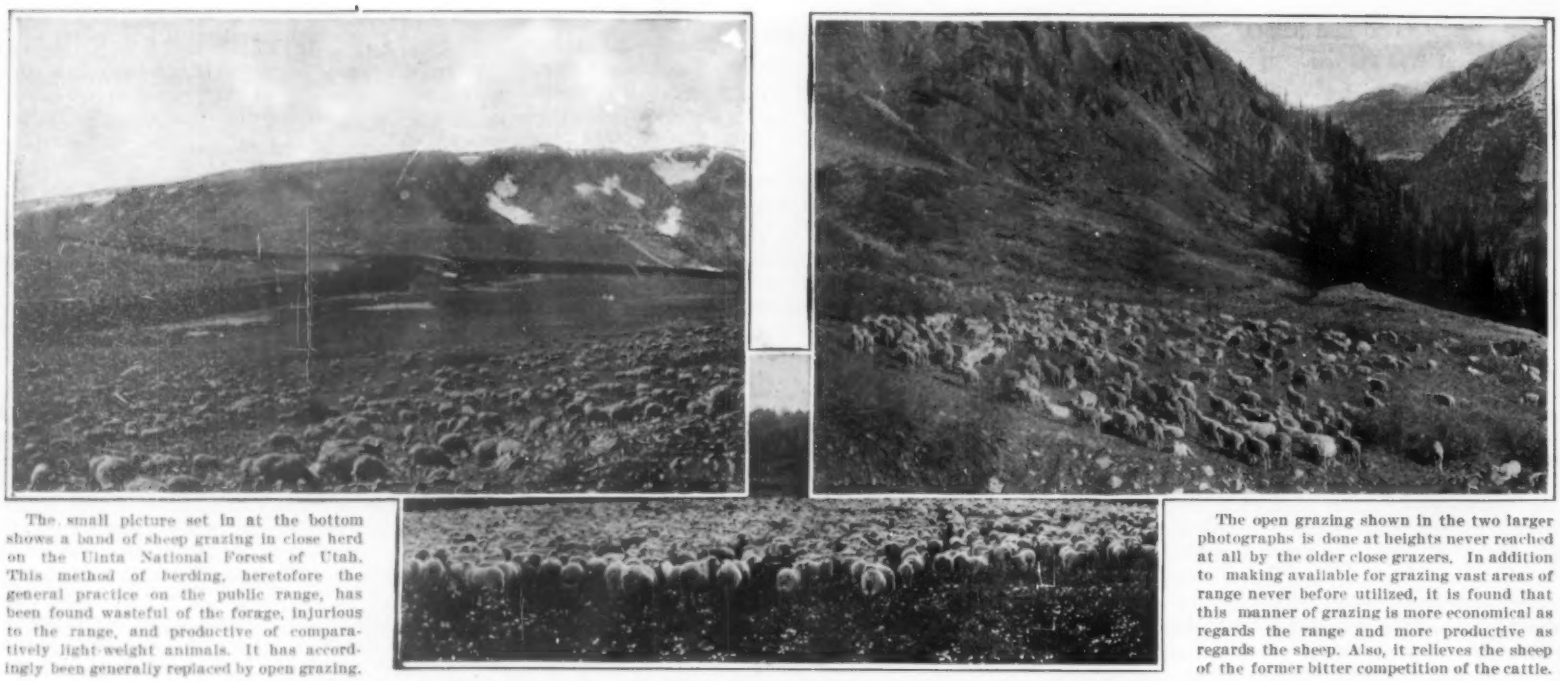
Automobile

Wrap Up Good Tools.—It is an admirable idea to wrap good tools such as polished pliers, wrenches, etc., in oiled cloths before stowing them away in the tool compartment, as the oiled cloths prevent them from becoming rusty or marred, which is quite likely to happen if the brightly finished surfaces are exposed for any length of time. Files should be wrapped to protect the cutting teeth, for if they are allowed to rattle around, they not only injure other tools but are injured themselves. Polished tools should never be carried in a tool compartment adjacent to a storage battery because the acid fumes will cause rusting of the polished surfaces.

Car-Track Driving Injures Solid Tires.—No matter how conscientious and careful a driver of a motor truck may be in avoiding bad pavement, skidding or faulty wheel alignment and the like, the temptation to skim down car tracks where there is smooth "going" is hard for him to resist. One of the biggest abuses solid tires are subjected to is this practice of car track riding, according to an official of a prominent rubber company. Aside from the element of danger attending skids from contact with the frogs and switches of street car tracks the premature depreciation of a tire is certain, because of the abnormal strain on a small section of the tire. When on the tracks most of the load is concentrated on a limited portion of the tread, so that it is overloaded and quickly worn away, besides, a sharp pointed frog may actually cut out a piece of the tire just as a knife would, this action being aggravated when the rails and rubber are wet.

Keep Distributor Clean and Dry.—Excessive oiling of a magneto can do nearly as much harm as insufficient lubrication. One thing it does is to cause the surplus oil to be thrown into the distributor, where it works all kinds of mischief. It gets between the brush and the contacts and either insulates them from each other entirely, causing missing, or it causes arcing. Arcing in turn burns the oil and forms soot which soon gums things up badly and it also produces heat which disintegrates the carbon brush and causes it to crumble in time. All magneto manufacturers make their distributors so that they may be removed easily and wiped with a dry, clean cloth. Some magnetos, for instance, have their distributors held on by three little clips, retained by three thumb nuts. These may be loosened by hand. Others have three screws or simple spring clips to retain the cover. Some have a central revolving brush and stationary contacts in the cover and others a revolving contact and individual stationary contacts in the cover. The brushes in either case are attached to small springs and may be slipped into or out of their sockets by hand. Absolute cleanliness is important in both forms.

Fill Holes in Tire Casings Promptly.—The motorist does not realize the great increase in tire mileage made possible by prompt attention to the many cuts and bruises to the tire tread which are apt to be neglected because they do not cause deflation. Water and sand works in between the plies through the cuts causing sand blisters which in turn usually result in a "blowout." For general use of motorists and in small shops a combination vulcanizer which is composed of a large hollow cast-iron body filled with water and heated with a spirit lamp, is marketed. In this the curved face and the flat face may be used simultaneously and an inner tube patched at the same time that the outer casing is being treated. As very complete instructions are furnished with these small vulcanizers, any motorist may become familiar with their use without much difficulty. In some vulcanizers, the heat is furnished by electricity passing through resistance coils imbedded in the device and are similar to an electric flat iron in action. In vulcanizing, the most important precaution is to maintain a proper temperature. Too great a degree of heat will burn the rubber, while a proper cure cannot be effected if the temperature is too low. The temperatures recommended for vulcanizing vary from 250 to 375 degrees F. The lower degree of heat is used in working material that has been previously cured, while the higher temperature is recommended for new rubber. Small thermometers may be obtained from any supply house to gage the temperature of the vulcanizer.



The small picture set in at the bottom shows a band of sheep grazing in close herd on the Uinta National Forest of Utah. This method of herding, heretofore the general practice on the public range, has been found wasteful of the forage, injurious to the range, and productive of comparatively light-weight animals. It has accordingly been generally replaced by open grazing.

The open grazing shown in the two larger photographs is done at heights never reached at all by the older close grazers. In addition to making available for grazing vast areas of range never before utilized, it is found that this manner of grazing is more economical as regards the range and more productive as regards the sheep. Also, it relieves the sheep of the former bitter competition of the cattle.

The right way and the wrong way of utilizing the public ranges of the Great West for sheep grazing

Mountain-Peak Grazing

How the Western Sheep-Growers Are Spreading Out Their Field of Operations Toward the Sky

By W. F. Wilcox

THE stern, rugged, hoary mountains of the western states, with snow clad peaks piercing the sky, represent to the easterner so much waste. But the economic values of these mountains are numerous. First they milk the clouds, storing up the snows and ice and rain till midsummer, when the resultant water plunges down just in time to irrigate the crops of the hot desert valleys below. Again these self-same cliffs and ledges are full of precious metals, which the keen eye of the prospector learns to discern. Also the mountain torrents furnish abundant water power. Then there are trees of commercial size on these mountain sides furnishing mine props and timbers and lumber, fire wood and posts for the farmer. The cool heights are attained by mountain roads and summer tourists flock here to get a breath of air and to recreate in the great out-doors. Here men and women secure their health and happiness. Then again, wild game abounds and lakes and streams are full of fish.

But the great use of these altitudes recently worked out is in the grazing of livestock. Before the transfer of the National forests from the Department of the Interior to the Department of Agriculture in 1905, very little sheep grazing was permitted in the National forests, which were then called Forest Reserves. What grazing done was confined to such states as Oregon and Washington, where rainfall was heavy and the forage crop renewed itself rapidly. Sheep growing in those days was more of a matter of tolerance than encouragement. Today the situation is reversed.

WHILE today may be, among the thoughtless, a carnival of waste reflected in high prices, there can be no doubt that more serious attention than ever before is being paid, here in the United States, to the utilization of every resource. A rugged chain of mountain peaks throwing its white-capped summits high into the clouds may not at first glance suggest any resources other than for the man who seeks out-of-door pleasures. But they possess economic values of high order, for all their forbidding exteriors. Some of these values are old and familiar enough save that we do not ordinarily associate them with the mountains, as such. But at least one represents the working out of an idea decidedly new to America; and it is of this that Mr. Wilcox, who has acquired familiarity with the subject through his membership in the Colorado state legislature, tells us in the present article.—THE EDITOR.

At first it was thought we must follow the footsteps of older countries, whose policies in handling their timber lands were to prevent grazing. To have heeded unqualifiedly the messages of Palestine, Switzerland, Sweden, Italy, China, British India, various German provinces and other countries of the world, would have meant that our National forests would be supporting much less sheep and other kinds of livestock than they are today. In many forests of the old world grazing is entirely prohibited and on the remainder is closely restricted or regulated. It was early recognized that the restrictive policies of older countries could not be adopted here. Our mountain conditions differ from those of older countries and are so varied that the restricted grazing policies that were necessary there, were not well adapted here.

As extensive additional areas in the Rocky Mountain and Pacific Coast regions were withdrawn for National forest purposes, including vast areas of summer pasture, the close restrictions formerly applied to forest lands were removed—else the sheep industry would have been seriously crippled, if not practically ruined in the mountain sections.

It was apparent that the old system of unrestricted use and unrestrained competition could not continue. This gave way to systematized methods. There has been gradually worked out in the National forests of this country, from a condition of chaos in which the forest officers first found such ranges as were to be used by sheep or cattle, certain fundamental principles that formed a foundation upon which has been built the first plan of controlled grazing the world has ever known.

The National forests in the United States proper now number 158 with a total area of 154½ million acres, including some 21 million acres of private lands. Nearly 75 per cent of this area is being used or is susceptible to use for livestock grazing purposes. About 8½ millions of sheep besides their lambs were accommodated last year. The establishment of the National forests has not reduced the sheep industry of that region. In fact, increasingly larger numbers are being accommodated, taking the National forests as a whole. Restrictions have been necessary in local instances, but those have been more than offset by increases and extensions elsewhere. In 1905, permits were issued for 1,514,330 sheep on the National forests; in 1906, 5,763,100; for several years the number ran between seven and eight million until last year, 8,512,208.

Sheep are usually assigned the higher ranges, above timber line areas and this has been the growing practice since 1905. There were immense areas above timber line untouched by hoof of stock of any kind, while at the lower altitudes both cattle and sheep were competing strongly for the given areas. In most sections of this country it wasn't a question so much of the injury sheep might do to young forest growth but the destruction of the forage crop itself through unrestrained use. In general it should be stated, however, that sheep have proven injurious to yellow pine reproduction in the arid regions of Arizona and New Mexico. On the other hand areas in similar forests in California have been grazed extensively by sheep for 40 years with the result that young trees are gradually taking the range where forest fires are kept out. The question resolves itself into local or at least regional conditions; methods and policies must be worked out applicable to each region. At present practically all available areas are being utilized to a greater or less extent and additional stock on the range will in the main come from the adoption of better methods of handling, better distribution and in some instances the common use of general areas by both sheep and cattle.

It was a great stroke of economic practice to allow sheep on the upper areas above timber line. Between one-quarter and one-third of the National forest area in states like Colorado and California is above timber line. Perhaps one-half of this above-timber-line area is sheep range, and the remainder too rugged or barren for use by domestic stock. So in round figures about one-sixth of the National forest area is today in sheep range above the timber line. Colorado has more such area in proportion to National forest area than any other state, unless it might be California.

This high range is much desired by sheepmen and happy is he who draws a portion of it. The season is short but it is mighty fine. The nights are cool and snow may fall any time and this is why it is impossible to keep cattle so high up but it does not worry the woolies. The feed varies according to local conditions. There is abundance of moisture at high altitudes. There are grasses and weeds, the latter highly favored by sheepmen. It might seem strange to some that a range of weeds and flowers is eagerly sought by flockmasters. It is the truth. Among the grasses of the forest reserves are various bunch and meadow grasses, the principal ones being the so-called mountain bunch-grass, pine bunch-grass, wild timothy, rye, red-top,

(Continued on page 122)

Electricity and the Census

A Glance at the Machines That Make Our Decennial Inventory a Matter of Weeks Instead of Years

By J. A. Stewart

THE Fourteenth Federal Census covering the ten years ending December 31, 1919, is a subject of wide interest. It is a colossal enterprise. An army of workers is required for it. More than these, it needs a complete scientific and mechanical corps and equipment.

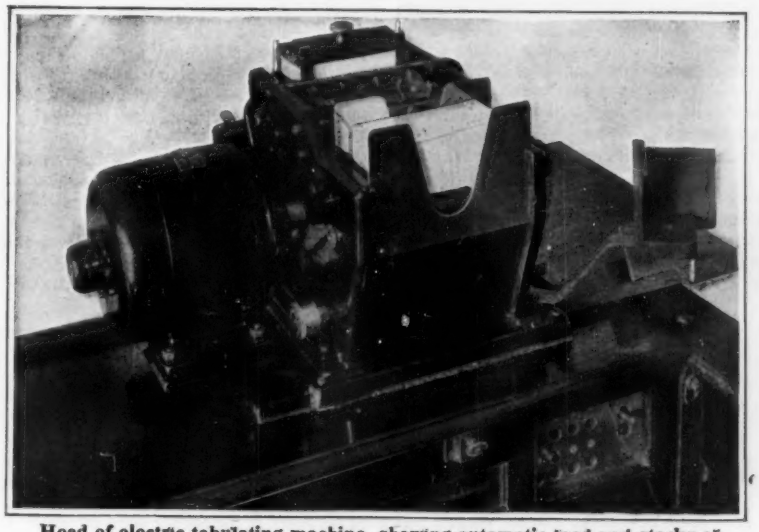
But for the invention of machines capable of arranging and adding figures more rapidly than can be done by human hand and mind, the taking of a Federal census nowadays would be impracticable.

Electricity has solved the big problem of digesting the schedules filled and sent in by the great host of enumerators in the field. Collecting the information is but the introductory part of the census. There remains the vital work of accurately compiling tens of millions of schedules and condensing them for publication.

It is here that the mechanical powers came to the rescue. Invention has performed a tremendous service for the provision of needed Federal statistics. The old method of computing the facts contained in the census was by a laborious system of hand-tallying. Every fact relating to each person was indicated by a pencil mark under the proper heading on big sheets provided for the purpose. This plan was clumsy, slow and very liable to error. So slow was the work that the last volume of the census of 1890 was not off the press until seven years after beginning the task of enumerating the population. In the Tenth Census (1880) the last of the volumes was published in 1889. This represented a fair rate of speed, considering the dozens of bulky volumes required. But the lack of prompt publication seriously impaired the value of some of the most important statistics which were quite out of date before the public got them.

It was a former employee of the Bureau who invented the useful electric tabulating machinery which has proved such a boon to the statisticians of the Federal Census. This machinery was first used at the Twelfth Census (1890), the director of which estimated that if the tallies of age, sex, nativity and occupation had been made by hand, it would have required the labor of one hundred clerks for seven years, eleven months and five days. It was found that electrical machinery saved nine-tenths of the time, two-thirds of the cost of hand work, and at least $5,000,000 to the Government, besides being more accurate! In addition the machines enabled the census clerks to count combinations of facts.

Profiteers having secured control of these valuable machines the Director of the Census employed experts to invent electrical machinery for the work, Congress making an appropriation for the purpose. The Government had paid $750,000 for the rental of the machines. With its own at the 13th census half a million dollars were saved.



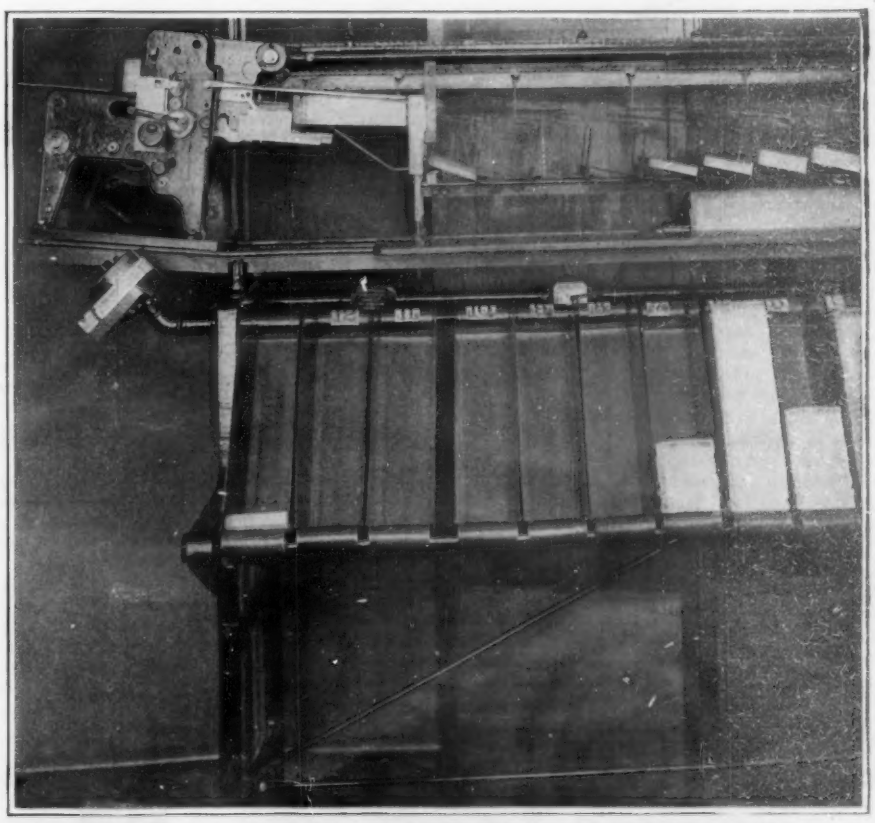
Head of electric tabulating machine, showing automatic feed and stacks of cards in position before and after tabulation

The card-sorting and the card-tabulating machinery of the census is simple, highly perfected, and splendidly efficient. In operating, the symbols for each are inserted by editors over the items in the various columns of the schedules to form divisions. The facts relating to sex, age, race, birthplace and other subjects of inquiry are indicated on individual cards by punching holes through the symbols corresponding to those on the schedules. Something like four million cards can be punched in a day by the army of clerks with the electrically operated punching machine. The punched cards are automatically fed to the tabulating machines. Wherever there is a punch in a card an electrical connection is established by a blunt needle passing through the hole into a cup of mercury and the fact is registered. On the machines first used there was a series of dials from which the figures were copied off on "result slips" and filed for the compiling clerks. With the later machines this operation is entirely cut out. They are equipped with an automatic attachment for printing the totals (for each unit of area, district township, ward, city, county or state) and operate at the approximate rate of 24,000 cards an hour.

It will require about 110,000,000 cards to record the population—a stack over ten miles high. As each of these cards is passed through the tabulating machines six times, more than half a billion electrical connections are made in tabulating the population of 1920.

Accuracy is the slogan of the Census Bureau. Each punching machine operator is watched to see that the wrong keys are not hit. And the alert tabulating machine with higher mechanical intelligence not only refuses to ring up when one of the insufficiently punched cards passes through but also stops until the offending card is taken out. It is then up to the operator to go back to the schedules and supply the missing information.

The tabulating machine, open to show the record sheet upon which it prints the totals from 60 counters, giving the details of each group of cards and the total number of each variety handled



The machine that sorts the cards into any number of groups up to twelve, according to the data which they show. It handles 320 cards a minute, and rejects any that show impossible combinations of facts

Anti-Corrosion Engineering

A Practical Method for Preventing the Destruction of Steam and Hot-Water Pipes

By Professor Wm. H. Walker, Ph.D.

IT is a truism to say that the pure science of yesterday is the applied science of today. In 1907 the Research Laboratory of Applied Chemistry of the Massachusetts Institute of Technology published an article in which for the first time the function of oxygen in the corrosion of iron was clearly set forth. Other influences were analyzed, and the true nature of the phenomenon of rusting was explained. Briefly the basic principles underlying the corrosion of iron are as follows:

Corrosion is an electrolytic phenomenon and can be understood on purely electrochemical grounds. It takes place at ordinary temperatures only in the presence of water and through the following reaction:

$$Fe + 2H' \rightarrow Fe'' + 2H$$

This means that a metallic iron atom, electrically neutral, interacts with two hydrogen ions present in the water and which carry electrical charges; the result is the production of an iron ion which takes up the two electrical charges from the hydrogen ions and the deposition of two atoms of hydrogen. Energy is lost to the surroundings and appears as heat.

Among the factors which influence the action the *first* is *the solution pressure of the iron*. This is constant for all samples of iron under constant conditions, but may be influenced by a number of agents. Thus the immunity of iron to corrosion in solutions of chromic acid is caused by the passivity of the iron—a thing, which, whatever its true nature, is equivalent to lowering the electrolytic solution-pressure of the metal.

The impression of an external e.m.f. may also be considered as equivalent to a change in solution pressure. This may be either positive or negative in its direction. If the potential employed be mechanically generated, we speak of it as "stray currents," but if electrochemical in its origin, it is described as the accelerating or retarding effect of other bodies. Thus iron, which itself is incapable of corrosion when imbedded in concrete, is severely attacked if its solution pressure be sufficiently increased by having superimposed upon its own potential an external e.m.f. due to stray currents. On the other hand, the potential of iron may be so depressed by an impressed e.m.f. due, for example, to the solution pressure of zinc, that the iron in contact with zinc will not corrode.

A second consideration is the number of the hydrogen ions. The greater the concentration, the more rapid will be the corrosive action. Hence, if any substance forming hydrogen ions, such as carbonic acid or bicarbonate or sulphur dioxide or any acid-forming compound, be present, corrosion is accelerated. On the other hand, if an alkaline material such as soda ash or caustic soda be present, the number of hydrogen ions is decreased and corrosion is retarded. If enough hydroxyl (the active ion of an alkaline compound) be present, practically all of the hydrogen will disappear and corrosion will entirely cease.

A third factor is the ease with which the hydrogen ion reaches the iron. For example, the wonderful resistance of sheet steel containing small quantities of copper to corrosion when used as roofing is due to the adherent nature of the film of oxide produced when corrosion starts. This film, as in the case of the aluminum oxide coat on metallic aluminum, effectually protects the metal and practically prevents further corrosion.

A fourth item, the osmotic pressure of the iron ions, is so small in any case that it is negligible; in the presence of oxygen it is kept extremely low owing to the formation of insoluble iron hydroxide.

Fifth, there is the deposition of the hydrogen and its removal by the depolarizing action of oxygen. The accelerating action of metals such as platinum, copper, and lead, and materials such as coke and mill-scale, upon the corrosion of iron are due alone to the aid these bodies offer to the elimination of the hydrogen produced by the corrosion reaction, owing both to the low overvoltage of hydrogen upon these substances and to the high catalytic action of these materials on the hydrogen-oxygen reaction by which the deposited hydrogen film is removed. The retarding action of the hydrogen film which is stable in the absence of oxygen and any acid-forming compound is so controlling, that from this point of view, oxygen (or air) may be said to be the cause of corrosion.

Both laboratory and large-scale experimentation demonstrate that the rate of corrosion is directly proportional to the amount of oxygen dissolved in the water. Furthermore, the curve representing the results passes through the zero point, showing that if no oxygen be present, there will be zero corrosion.

EVERY real-estate owner knows that one of the least long-lived parts of his property is the water pipes, especially when these are of the iron which on every other ground than permanence is so much to be preferred. In attempting to prevent the corrosion of these pipes, obviously the first thing to do is to learn the cause. Professor Walker's article shows clearly and convincingly what this is, and that it is a thing which cannot be prevented from operating. So the remedy which he proposes is the logical one—let the heated water corrode a mass of easily replacable junk metal in a tank in the basement, rather than the expensive pipes through the building.—THE EDITOR.

It is interesting to note how these scientific facts have been made the basis of improvements in engineering practice, and how the dangers and losses due to the corrosion of iron are constantly being decreased.

Two recent advances in anti-corrosion engineering are, first, a process for eliminating the mill scale from the inside of steel pipe, and second, a process for removing the dissolved oxygen from feed water for boilers or hot water supply systems. The first depends upon the fact that there exists a temperature where steel is plastic and easily deformed, but where mill scale is brittle and non-elastic. If now a welded pipe be cooled to this temperature, and held there while it is subjected to mechanical working, the pipe is not permanently deformed but the scale loses its adherence and falls off. Deprived of its accelerative centers of corrosion, such a pipe, while still subjected to corrosion, suffers uniformly but slightly over its entire surface, instead of concentrating such action on the exposed points between the mill scale layers, with the consequent formation of dangerous pits and seams.

The second advance depends upon removing from feed water, by the regulated and accelerated corrosion of a cheap form of iron, all of the dissolved oxygen which the water naturally contains. The disappearance of the oxygen is due to two effects. Part of it is consumed in uniting with the hydrogen set free by the dissolving iron, while the remainder is consumed in oxidizing the ferrous hydroxide formed by this solution to the more stable form familiar to all as rust. Obviously if ferrous hydroxide be introduced into the water from without, it will quickly unite with the dissolved oxygen and in this way permit the separated hydrogen to protect the iron continuously from further solution.

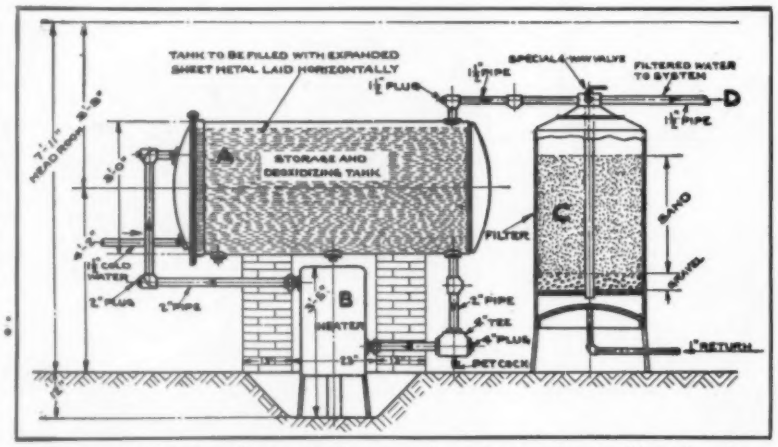
Water from which the free oxygen has been removed is no longer active in producing corrosion, and hence an apparatus for removing it is called a "deactivator." A number of installations have been made in apartment houses in which serious loss had already been occasioned by clogging of the hot water supply system with accumulated rust, by leakage due to complete failure of the pipes owing to corrosions, and by constant complaints by the tenants of the presence of rust in the water supplied.

A typical installation is shown in the attached figure. It consists in the tank, A, in which is placed a large number of perforated sheets of iron over and through which the incoming water must pass. The water is heated by circulating through the heater B as shown by the arrows. During its passage through this tank, the oxygen of the water is consumed producing an equivalent quantity of the red iron hydroxide, a portion of which remains in the tank while a portion passes with the water to the sand filter C. Here all of the floating rust is removed and a clear, pure deactivated water is supplied to the apartments through the exit pipe D. The return water of the circulating system through the apartments is continuously passed through the central pipe of the filter, where it is reheated and returned to the main supply line.

The removal of the dissolved oxygen from the water thus effected is shown by a 9-months survey to be almost mathematically complete.

That this removal of oxygen is accompanied by highly beneficial results is shown by comparison of the present and past conditions of the supply system of one apartment. At the time when the deactivator was installed, March, 1917, the hot water system had been in service for eleven years, the supply tank had been corroded through and subsequently plugged in three separate places, numerous leaks had occurred in the piping system, and the pressure at the top of the house had fallen to a very low value. Since the deactivator was placed in service there have been no further breaks in the tank or system, the pipe lines have cleared themselves so that the pressure is normal, and the water supply to the tenants is free from rust.

The logic of the process is convincing. It is much cheaper and vastly more convenient to corrode away 100 pounds of sheet metal easily replaceable in the basement, than the same weight of piping throughout the house where replacement is exceedingly difficult and expensive. After two years' experience the process recommends itself as a practical means of overcoming a serious difficulty.



The proposed system for preventing corrosion of water pipes and keeping the resulting rust out of the hot-water supply

X-Rays in Analysis

DURING the work, which has been in progress for some years, looking to the use of X-rays for detecting flaws in steel, it has been found that the method may eventually have some importance in preliminary analytical work. This is based on the fact that when an element of high atomic weight such as tungsten is present in considerable quantity the steel is not so permeable to the X-rays as when the quantity is less. This may be of service for rapid analysis during the course of manufacture.

Thus far flaws within two inches of the surface may be detected but experimenters are confident that apparatus now nearing completion will make it possible to reach a depth of nine inches. This method of examination has the immense advantage that finished articles are not damaged. Welds may be easily inspected for defects and success in modifying methods of manufacture has already resulted from the use of X-rays for examination.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Early last fall it will be remembered that we printed some letters discussing the metric system, and a single installment of the answers which had been provoked by these. We had planned to continue the discussion, but the printers' strike made our space so valuable that we had to drop the matter for the time. We are very glad to return to it now, and to print here several letters which bring forward arguments or suggestions that seem worthy of the light.—THE EDITOR.

Inches vs. Meters

To the Editor of the SCIENTIFIC AMERICAN:

Mr. Halsey's letter in your issue of September 20th last is very interesting, especially in his reference to the bad habit the ancient races had of counting on their fingers and thumbs. For had they omitted their thumbs and employed only eight digits in place of ten, we should have a system of arithmetic combining the advantages of the decimal and the binary; and the metric system would already exist, here as elsewhere.

But in his objections to the metric system I consider his letter far from the point. For how can an adoption of the decimal system of measurements affect any existing standards of mechanical construction? All pipe fittings are very different from their listed dimensions; a half-inch wrought-iron pipe measures about ⅞ inch outside diameter and nearly ⅝ inside. Other pipe sizes are almost as much off their listed dimensions. But the existing pipe standards and listed sizes will as long outlive the present clumsy system of measurements, as the present system of sizing nails, sixpenny, eightpenny, tenpenny, etc., has outlived the old colonial system of shillings and pence from which the nails got their sizes.

And surely air-coupling for railway cars will not have to be changed when we adopt the universal system of measurements. JOSEPH H. BROOKS.

West Peabody, Mass.

A Metric Non Sequitur

To the Editor of the SCIENTIFIC AMERICAN:

May I have some of your space to comment upon Mr. Halsey's extraordinary argument against the metric system? This argument is, in effect, that enormous steps in standardization have been made using the inch as the unit of length, and that therefore the use of the inch is to be credited with all the benefits of standardization. If Mr. Halsey made any effort to show that the same standardization could not have been effected under any other system of measurement his argument might stand up; but in the absence of such effort it is pure poppycock. I am at a loss to understand why you should even print it, unless to make Mr. Halsey and his cause appear as ridiculous as they are.

I don't know what Mr. Halsey's politics are; let us assume for the sake of argument that he is a Democrat. If he applies the same logic to all things that he does to mensuration, it will then be necessary for him to admit that the recent rainy summer is to be laid at the door of his party. Behold: the Democrats were in, and it rained all summer—*post hoc, ergo propter hoc.*

As I understand this standardization business, the advantage is entirely that of having the pipes or the couplings or the gages or the wrenches or the whatnots made in the same sizes everywhere. What in the world difference does it make whether we measure these sizes in inches or in millimeters or in tenth-inches or in any other unit that happens to be imposed upon us? That is, what *a priori* difference does it make? Modern precision methods are on a footing where we can just as easily measure .3937 inch as we can an even inch; the additional figures, which terrify the layman mean nothing to the expert, who understands that there are also four significant decimal figures in 1.0000 inch, and that his job of getting the measurement right within the desired margin is just as hard—and just as easy—whether the final figures are zeros or whether they are not.

So the initial work of standardization is utterly independent of the particular system of measurements under which it is carried out. It happened that a lot of valuable standardization was done by people using the inch system. But what of it? We might as well inquire whether Westinghouse was a Baptist or a Congregationalist, as to attribute the development of standard sizes in brake-couplings to the fact that they are measured in inches instead of in centimeters. We might just as well say that because our favorite magazine is set in 8-point type, all matter published in a different font is revolutionary and Bolshevist and richly deserving of suppression.

Mr. Halsey, however, does not rest content with putting up an utterly fraudulent argument. He proceeds to knock his own argument right down. The objection to the metric system of Mr. Halsey and the organization whose viewpoints he voices, presumably as a paid secretary is, in last analysis, that it would cost them a lot of money to make their tools and gages over in conformity with a metric system if the latter were introduced. Accordingly it is customary for them to feature these tools and gages as the cardinal elements of strength and value in the application of the inch system. Yet here is the good Mr. Halsey, assuring us that the "real value" of the standard couplings "lies in the results they accomplish," and that we would be very foolish to measure their value "in terms of the special tools and measuring instruments with which they are made!"

If this be true, the most serious obstacle to the success of the metric system has been overthrown by the enemies of that system. Mr. Halsey, speaking for those enemies, tells us in so many words that in order for the inch system to prevail over the metric, it must show a superiority of actual performance, it must do something that the metric system cannot do; the tools which it uses, and which would have to be discarded if it were dropped, are of no consequence. And if we insist that the performance attributed to the inch system be something for which it is really responsible, and not, as in the cases cited by Mr. Halsey, merely something contemporaneous with the use of the inch system, as the invention of the telegraph was contemporaneous with the administration of President Tyler, its advocates will have their hands full making out a case for it.

By the way: when Mr. Halsey writes on the subject of Inches vs. Meters, I have never known him to be so temperate. Can it be that he is learning that violence never gets him anywhere—or is it merely that you have edited him, and expurgated some of the vituperation from his normal epistolary style?

METRICUS.

New York.

The Eight-Digit System

To the Editor of the SCIENTIFIC AMERICAN:

The metric system is proposed chiefly because many countries are using it and therefore, it is supposed, trade will be promoted between those nations which can readily do business in familiar terms of weights and measures.

Of course a single universal system is preferable to the many now in use—that admits of no argument. But is it wise to abandon a system which is at least rational for a system which has been shown to possess not a single rational feature, simply because other nations use it? Such a reason is unworthy of this great nation.

Great Britain some years ago stated that no change would be made in their system until it could be replaced by a perfect system. And this is reasonable enough. If we are going to change our system of measures, this is a change of so far-reaching a nature that we cannot afford to experiment. We have a system that works, and with which we are acquainted; let us keep it until we can clearly perceive, in a suggested substitute, the perfect system which we shall never want to discard again.

Mr. F. A. Halsey, in your issue of September 20th last, says: "Not one base unit in this scientific system conforms to definition." Everybody knows that this statement is absolutely correct. And I will add: No mathematically perfect decimal subdivision was ever made of any metric quantity, nor ever will be. This is a fundamental defect of the decimal system, arising from the very nature of the number 10, employed as its base. If we are to remedy the present confusion of measures we must strike deeper than the effect, and seek for the cause. Here it is; what are we to do about it?

Obviously we must either let the whole matter severely alone, or else boldly change the system of notation. That this is not so absurd as it sounds will be plain if we but reflect that binary and sexagesimal and duodecimal systems have been used at one time or another in the world's history—and doubtless also quinary ones as well. The Romans did not even have a consistent system, but attempted a compromise between the base 5 and the base 10. The Babylonians did the same with 10 and 6. So what we ought to do is to ask what number is the most advantageous one for the base of numeration.

The binary system is best on one ground—that of simplicity and avoidance of irrationals. But it requires too many digits to express comparatively small numbers. In the effort to escape this trouble, the base 2 has been combined with the base 3 to give us the sexenary system on the base 6; but here we lose the advantage of universal rationality. We can do better than that by taking the base 8 for an octonary system; and here we will retain the universal rationality, and use in the long run even less digits than in the 6-system. We get all the natural advantages of the binary system of repeated halvings without any of its drawbacks.

The octonary radix of figures is rational and it succeeds because it is a universal binary system of numbers and binary subdivisions are possible in all directions; in fact the binary method is the only method of continuous subdivision known to the geometrician. Hence our system of fractions, cumbersome as they are, are perfectly natural; but if an octonary arithmetic were used instead of the decimal measures of all kinds, arithmetic would correspond delightfully and fractions would be unknown.

While the metricists persist in counting on their fingers and thumbs and denounce the binary system, they cut the dollar into two halves; find the quarter in the same way and get stuck in trying to produce the "bit"; they cut this planet into halves to find the equator; and cut every rational base into binary subdivisions wherever it is possible, because they can do nothing else and know that it is perfectly subdivided. It is even recorded that two cats called in the monkey to settle their quarrel by a binary division of a piece of cheese on a binary scale. That the cats got no satisfaction was due to the monkey monkeying with the system.

The government should appoint a commission to test the octonary, or any other system, and give the world that one which proves itself to be universally and conveniently adapted to the needs of mechanical science and trade. GEO. H. COOPER.

San Jose, Cal.

Preserving Books in the Tropics

To the Editor of the SCIENTIFIC AMERICAN:

We are readers of your execellent publication and notice the letter of Mr. Rosenheim in your issue of July 26th last. We can tell him that to get rid not only of bookworms but of everything else that will eat and damage books including mildew he will find the following efficacious. Put the books inside an airtight box of metal or wood. On top of them place a saucer or a shallow tin can filled with cotton. Once a day for three days saturate this cotton with carbon bisulfide, closing the box tightly. Do this every six months or so, putting the books back in the box again, and you are absolutely protected. This is the way we preserve our valuable books here, with complete success. SULA ICE CO.

San Pedro Sula, Honduras.

Eight Hours in Exchange for Sixteen

To the Editor of the SCIENTIFIC AMERICAN:

Your editorial of August 23rd, "The High Cost of Loafing," hits the nail squarely on the head. It brings before me very clearly another and slightly different aspect of the present high-price orgy which has just been drawn forcibly to my attention. During an extensive automobile trip through eastern Ohio, southern New York and Pennsylvania, in which 1,100 miles were covered, I could not help noticing the absence of young men on the farms. Three-fourths of the labor consisted of middle-aged or old men. It is plain to see why this is so. The young men can work in any of the other industries for eight hours per day, and get more money than by working 12 to 16 hours on the farm. The eight-hour day cannot be applied to the farm without greatly increasing expenses.

Now I don't suppose anybody will dispute that the fundamental factor in the high cost of living is the high cost of foodstuffs. If foodstuffs were to be produced on an eight-hour basis, I don't believe anybody can estimate the increase that would be brought about in their cost. The farmer will not go on indefinitely exchanging his 12 to 16 hours for the products of the other fellow's eight hours; and when he demands that the swap be put on an even basis, what will happen to the price of food?

C. F. PHILLIPS.

Chagrin Falls, Ohio.

Concrete lighthouse on the Barge Canal

The New York State Barge Canal—IV

The Present Traffic and Future Prospects of the New Waterway

By Edward S. Walsh, Superintendent of Public Works

THE 1919 season of navigation on the improved canals of New York State, brought to a close November 30th, was a successful one. For the first time in many years the tonnage carried exceeded the total of the preceding season and this is taken as indicative of a reawakening of interest on the part of shippers in canal transportation.

The traffic for the season aggregated 1,238,844 tons. In view of the 20,000,000-ton capacity of the waterway, the commerce of 1919 is relatively small, nevertheless, when it is considered that the traffic decline for the last decade or more has averaged nearly 15 per cent annually, the 7 per cent increase shown by the 1919 season is an encouraging omen. It shows that the steady annual diminution in traffic has at last been arrested and once again commerce on the New York State Waterways is on the upward trend.

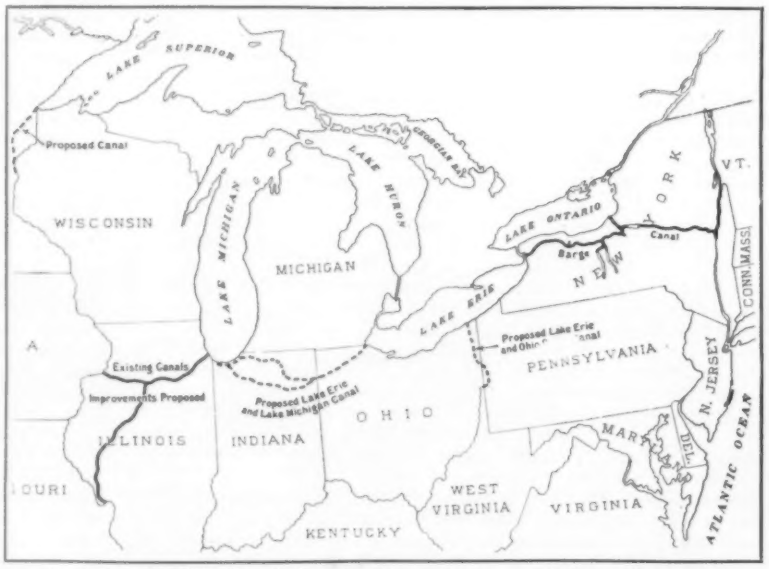
An analysis of the traffic carried during the past season shows that in 1919, more than ever before, the waterway was utilized for the shipment of commodities of the higher class. A splendid increase in the tonnage of manufactured articles was made and large quantities of machinery and tools, petroleum and petroleum products, iron and steel articles and miscellaneous merchandise were carried. The distribution in tons of commodities by classes was as follows: Manufactured products, 203,307; products of animals, 786; miscellaneous products, 63,939; products of agriculture, 184,899; products of the forest, 194,807; products of the ground, 591,106.

There were approximately 700 boats engaged in trade on the waterway during the season. For the most part, these barges were what is known as the "old type," that is, boats 98 feet long and 17 feet beam, designed for service on the old Erie Canal and loading about 250 tons on their maximum draft of 7 feet. Less than 75 new barges were in service. The United States Railroad Administration operated a fleet of 57 barges of the so-called "new type," 51 of steel, three of concrete and three of wood construction. These barges were 150 feet in length, 21½ feet wide and designed to carry 750 tons on maximum draft. The steel barges cost about $35,000 each. Shipping experts differ as to the efficiency of these steel barges, but the experience of the 1919 season clearly indicated that their operation in company with power units of the old type was hazardous in the extreme. It remains to be seen, however, whether or not they may be navigated with safety to the locks and other structures when in the tow of power boats particularly designed for such service.

The concrete barges are considered a failure. While their construction for inland water navigation was merely an experiment, it was found that because of their excessive light-draft, they cannot compete with barges of wood or steel construction. The concrete boats draw 4 feet and more when light, whereas the light-draft of the steel and wooden barges of the same size does not exceed 36 inches. The operating costs of the three types being practically the same, the lesser carrying capacity of the concrete barge resulting from its greater light-draft, eliminates barges of that type for commercial use.

There is an urgent need on the new waterway of a large number of new-type barges and a transportation organization conducting its operations in a manner meeting the requirements of present-day commerce. Many are willing to go ahead with the formation of canal transportation companies under certain conditions and the controlling conditions are that Federal utilization and operation of the New York waterways be discontinued. In 1918, as a war measure, the Federal Government took over the transportation facilities of the waterway. With the war at an end, the necessity for Federal operations has been eliminated. Private enterprise is reluctant to compete with the Federal Government, consequently, as long as the Government continues its operations private initiative is discouraged. The situation demands, therefore, that the Federal Government withdraw from the field, terminating its canal activity coincidently with the return of the railroad lines to their private owners. Transportation legislation pending in Congress proposes to transfer the Government's inland waterway activities from the Railroad Administration to the Shipping Board and, unless the Shipping Board sells or charters the barges built by the Government to a private transportation corporation, which it may do under the provisions of the Shipping Act, from the standpoint of New York State interests the transfer from the Railroad Administration to the Shipping Board will be a case of "out of the frying pan into the fire." For under such a plan there would still be in operation on the canal a governmentally subsidized transportation line, with which independent carriers could not compete on a fair basis and with which they decline to attempt to compete. The representatives of the State in Congress have urged upon Congress the imperative necessity of relieving the canal system of what has proven to be an obstructing influence, and it is expected action will be taken to exclude the New York State waterways from the provisions of any measure authorizing the continuance of the Government's inland waterway operations. When this has been done, the State authorities are confident there will immediately spring up many strongly financed, well equipped lines and, thereafter, the task of rehabilitating commerce on the canals will be comparatively easy.

IN this, the concluding chapter of our series on the New York State Barge Canal, Mr. Edward S. Walsh, Superintendent of Public Works, deals with the economic aspects of the canal—its present and prospective carrying capacity and expectation of traffic. He proves how greatly the war has hindered canal operation, and we agree with him that Federal operation has served to discourage private initiative, and that, therefore, the Federal Government should withdraw from the field, terminating its canal activity coincidently with the return of the railroad lines to their private owners. And most decidedly do we agree with Mr. Williams that the proposed transfer of the canal from the Railroad Commission to the Shipping Board would be a case of "out of the frying pan into the fire."—THE EDITOR.



The Barge Canal in its relations to other waterways, existing and proposed

The exceedingly light grain traffic carried during the 1919 season was a great disappointment to the canal authorities, as it had been expected that in view of the bumper grain crops, the greatest the country ever had, large quantities of grain would be offered for shipment by the waterway from Buffalo. Notwithstanding the heavy crops and an acute car shortage obtaining in the fall, the canal carried less grain in 1919 than in any year in its history except 1918. The explanation of this strange condition is to be found in the Government control of both the rail system and the grain crop of the country. In an effort to bolster up railroad earnings and tonnage, Government authorities arbitrarily diverted much of the grain ordinarily routing to seaboard via the Great Lakes and canal, to the all-rail routes. Students of transportation, however, will appreciate this condition was an artificial one, for under normal conditions the cheap canal route from Buffalo to the Atlantic would have participated in the grain traffic to a very large extent.

Several large corporations have been quick to recognize the opportunity the waterway offers to lessen their transportation costs and have taken advantage of the opportunity. The General Electric Company of Schenectady, whose mammoth plant is located directly on the waterway, have acquired a number of barges which are being extensively utilized in the movement of raw materials and finished products between Schenectady and New York. A considerable percentage of the export traffic of this company is handled over the canal. The schedules maintained provide deliveries between Schenectady and New York on practically an express basis and the cost of transportation is appreciably lower than the rail rate.

The Standard Oil Company has purchased property adjacent to the canal at a number of points, such as Syracuse, Utica, Rome and others, on which large storage tanks have been erected. This company also built several tank barges and has used the waterway for the transportation of gasoline, kerosene and other petroleum products. The success of its operations, it is understood, have been such as to warrant a material expansion of the service in the future.

Other nationally known oil refiners have likewise foreseen a splendid means of reaching New York State markets by way of the canal and have acquired properties adjacent to the waterway at many of the larger cities of the state. These companies, it is expected, will place tank barges in service in the near future.

Even in Pennsylvania, there are manufacturing interests receiving benefits from the operation of the New York canals. At Bethlehem, Pennsylvania, a great steel plant receives large quantities of iron ore that finds its way to destination through the New York waterways. A navigation company owning and operating about 50 barges, some of them the 750-ton type, carries iron ore from Port Henry, New York, on Lake Champlain, to which point the ore is brought by rail from the mines in the Adirondacks, to New York harbor. At New York, the ore is transhipped by rail to Bethlehem and delivered at the steel plant at a cost much less than the all-rail rate.

The investigations leading to the construction of the Barge Canal brought out that under efficient operating conditions and with the proper type of boat, the cost of transportation on the improved waterway might be decreased to .52 of a mill per ton mile. While as yet the waterway has not achieved this unusually low cost basis, evidence is at hand indicating that the canal costs of transportation are being decreased and may, when the maximum development is reached, approximate the one-half mill per ton-mile figure. During the 1919 season of navigation, the canal steamer "E. T. Douglass" and push boat, owned and operated by the Shippers Navigation Company of Syracuse, New York, made a trip from New York City to Buffalo, a distance of 505 miles, in 112 hours. The steamer and consort carried a cargo of 380 tons and on all the facts of record, the cost of transportation was but 1.21 mills per ton-mile or 46 cents per ton. The time in transit, but four days and 16 hours, equals—in fact, under present conditions, ex-

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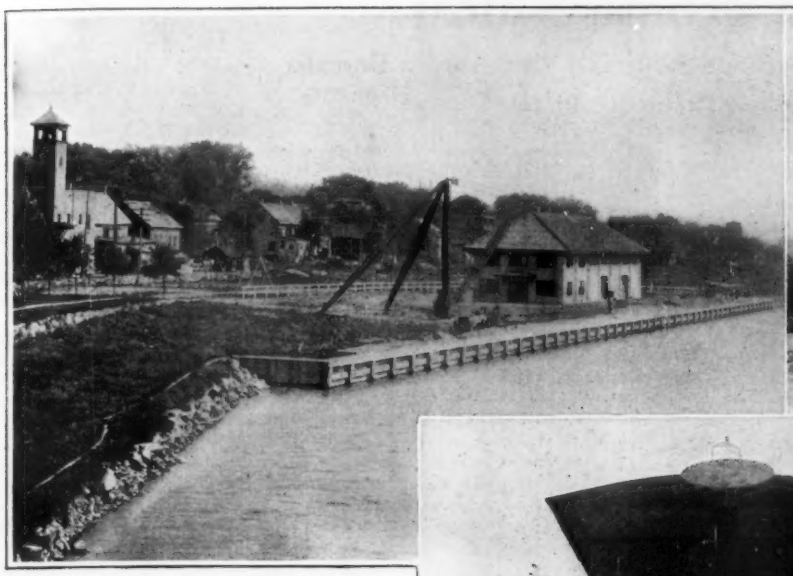
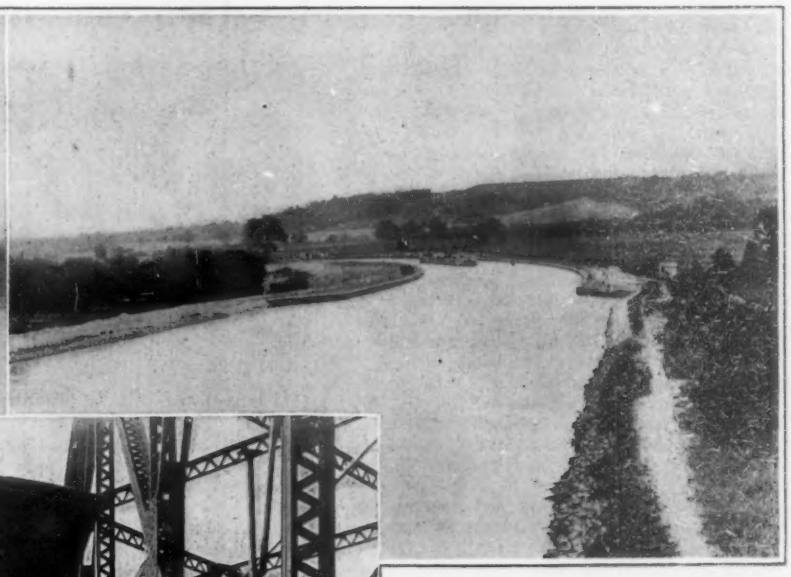
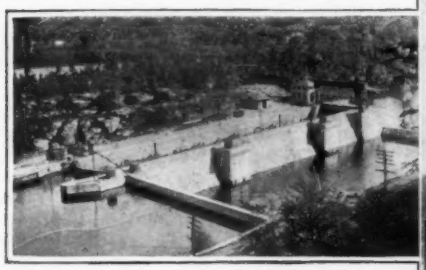


Standard type of terminal warehouse and derrick to be found along the Canal



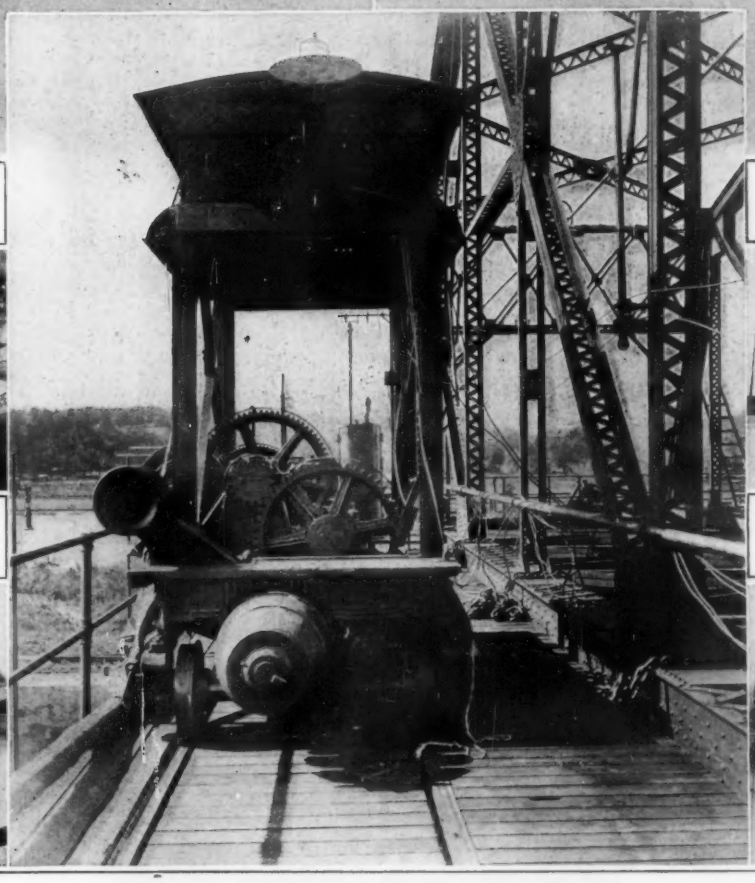
The finished channel, showing the land line, in the western part of the State



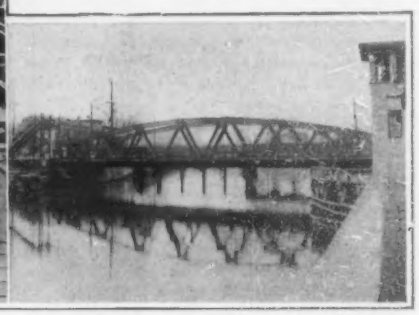
The lock at Little Falls with a lift of 40½ feet—highest in the world

Another warehouse, showing automobile crane with which they are all equipped

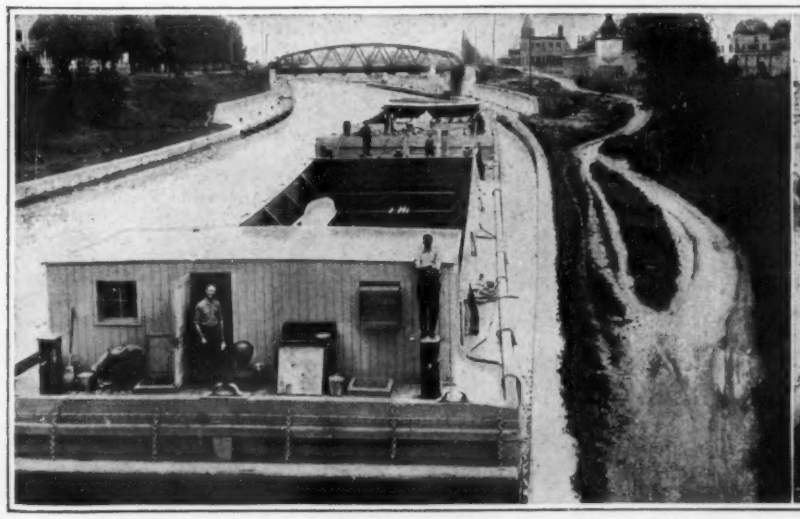
The freight-terminal shed and dock wall at Lockport



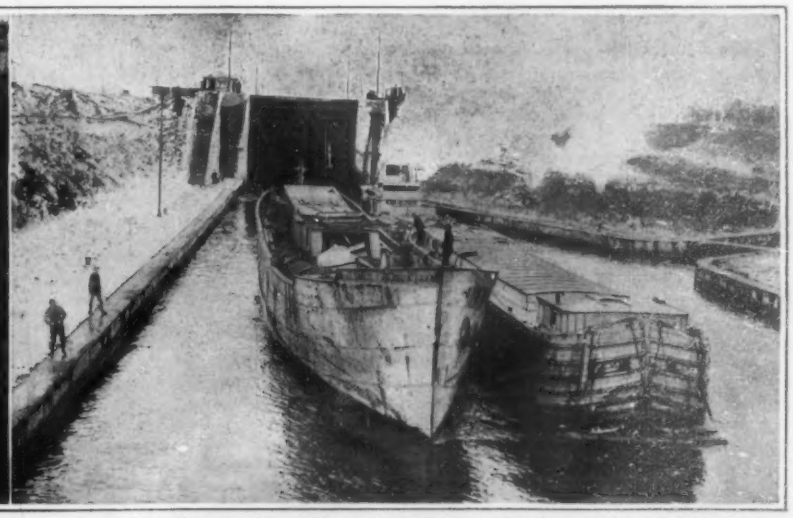
The electric winch used on movable dams of the bridge type to raise or lower the gates



A lift bridge that carries one of the streets of Little Falls across the new Canal



A United States Navy coal barge en route from the Great Lakes to New York through the Canal



A steel trawler leaving a Barge Canal dock. She draws 9½ feet of water, much more than the average craft using the Canal

SOME NOTABLE FEATURES OF THE DESIGN AND OPERATION OF NEW YORK'S NEW BARGE CANAL

The Heavens in February, 1920

Establishing the Connection Between Sun-Spots and Our Aurora Borealis

By Professor Henry Norris Russell, Ph.D.

WE described last month some of those enormous outbursts of luminous gas from the sun which are known as eruptive prominences, and told how these shining clouds had been followed on the photographs until they had risen hundreds of thousands of miles above the sun's surfac , and until at last they faded out.

What becomes of the ejected material after it stops shining? It is moving so fast that there can be no doubt that it flies off into space, clear away from the solar system into the great void between the stars; but what would happen if some of it hit the earth? An answer to this question which, though not certainly proved, appears very reasonable and probable, is found in an admirable bit of work which has just been published by Professor Lindemann of Oxford University.

Since men began to study the heavens, they must have wondered over the brilliant and mysterious exhibitions of the Aurora, or Northern Lights. Records of the appearance of these displays have been pretty well kept, and as soon as the periodicity of the sun-spots was discovered, it was found that there must be some connection between the two—auroras being frequent in years of many sun-spots, and fewer—in our latitudes very rare—when the spots are few. It was also found that whenever there was an aurora, there was a marked "magnetic storm"—that is, a disturbance of the earth's magnetic field, accompanied by the flowing of an electric current through the ground. Ordinarily these magnetic changes can be detected only by special recording instruments, but occasionally, in great magnetic storms, their effect is marked enough to be detected with an ordinary surveyor's compass—shifting the needle a degree or so. They are entirely different in nature from "electrical storms"—that is, thunderstorms—and without magnetic apparatus of some description no one would know they were taking place. They often occur when no aurora is visible—which is not surprising in view of the fact that one cannot see the Northern Lights by day, or in bad weather. Further study has shown that individual magnetic storms are often obviously associated with individual sun-spots—happening when the spot in question is near the center of the sun's disk, directly facing the earth, and usually when the spot is a little past the center, as though some influence were sent out which required time to reach the earth. Even very large spots often fail to produce any magnetic disturbances—which indicates that the influence, whatever it is, is not continuously acting.

The Solar Bombardment of the Earth

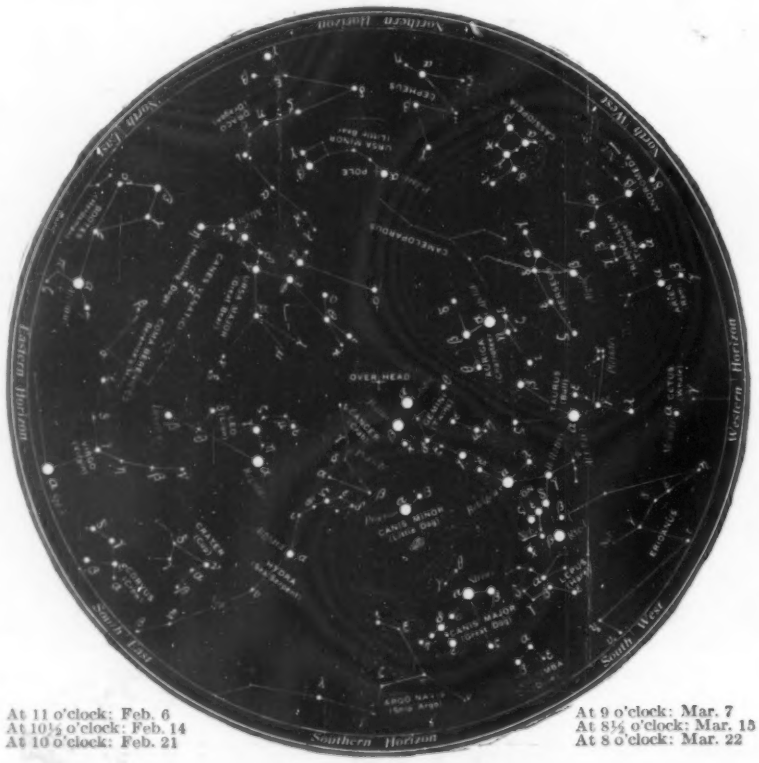
These facts suggest that the magnetic storms are in some way produced by something which is shot out from the sun-spots, or from their vicinity, not continuously and in all directions, but at intervals only and nearly straight away from the sun. From the time-lag which intervenes between the passage of the spot across the center of the sun's disk and the magnetic storm here on the earth, it appears that the ejected material takes, on the average, about two days to reach the earth's distance, which means a speed of rather more than 500 miles per second.

Observations of the Aurora, on the other hand, indicate that it is caused by the bombardment of the earth's atmosphere by minute electrified particles, or "corpuscles," which enter the atmosphere from outside, coming down along the lines of the earth's magnetic force, as such corpuscles must do. The auroral streamers begin at great and varying heights, but end always at the same level—a little more than sixty miles above the earth's surface. This of course indicates that the amount of air lying above the level in question is the greatest concentration through which the corpuscles, with their infinitesimal mass and their extremely high ratio of surface to bulk, can make headway.

Because of these facts, it has for some time been believed that auroral and magnetic storms are produced by the impact upon the earth of electrically charged particles emanating from the disturbed regions of the sun; and Dr. Chapman of Greenwich has shown that the electrical currents set up in the earth's outer atmosphere (which being highly rarified is capable of conducting electricity when ionized) would account for the general features of the observed magnetic disturbances. But it has always been very hard to see how a cloud of electrically charged particles could travel over the 90 million miles between here and the sun without being dissipated into space by the powerful internal repulsion of the individual charges; and also to imagine what force, even on the sun, could produce such clouds and set them in motion so fast.

Here is where Dr. Lindemann's new theory comes in.

Briefly stated, it is that the cloud of corpuscles is the remains of an eruptive prominence. The process which he supposes to happen is worked out in considerable detail, and with the aid of some of the most recent advances in knowledge of the nature of atoms.



At 11 o'clock: Feb. 6
At 10½ o'clock: Feb. 14
At 10 o'clock: Feb. 21

At 9 o'clock: Mar. 7
At 8½ o'clock: Mar. 15
At 8 o'clock: Mar. 22

At 9½ o'clock: March 1

NIGHT SKY: FEBRUARY AND MARCH

Atomic Disturbances that Bulk Large

Consider an atom of hydrogen in a solar prominence. According to our present views, it consists of a small (and relatively heavy) nucleus, with a positive electrical charge, and a single electron, with an equal electrical charge, revolving about the nucleus in an orbit. If the motion of this electron is disturbed, say by light pulling on the atom, the electron may be forced out of its orbit, and set moving instead in any one of a series of larger orbits, from which it almost immediately falls back into the original stable orbit, and, while doing so, radiates light, corresponding to one of the lines in the hydrogen spectrum. Conversely, while it is being pulled out to the outer orbit, light is absorbed. If the disturbance is violent enough, the electron may be knocked clean away, to travel off independently of the nucleus. At ordinary pressures, where the atoms are fairly close together, the nucleus is practically sure to come upon some other loose electron after a very short time; and the attraction between the two will pull them together and form a new hydrogen atom. But if the gas were exceedingly rarified, so that the atoms were far apart, and hit one another but rarely, the chance of picking up a loose electron would be small. Meanwhile, neither the isolated nucleus nor the free electron would, or could, absorb or give out any light at all.

For every time the atom absorbs energy from the outgoing sunlight, it is subject to radiation pressure, and receives a tiny impulse, or "kick" forcing it away from the sun. Since the mass of the atom is very small, this impulse sets it moving at a perceptible rate, which, for a single encounter, can be calculated to be a little more than two feet per second. But things happen very fast inside an atom, and the number of such impulses may be large, so that their net effect overcomes gravity, and drives the atom away from the sun.

All the while it will be shining, for it gives out light every time the displaced electron comes back to normal and gets ready for another turn at the game; but finally it will get such a big kick that the electron is knocked clear out of it, and then it will no longer be luminous. Only a very short light-wave can drive the electron out like this, and the sun gives off very little of this extreme ultra-violet light. Hence Lindemann figures that the atom may receive and recover from as many as a million smaller blows from longer light-waves before it is finally "knocked out"; and by this time the cumulative effect of the impulses it has received should set it flying away from the sun at about 500 miles per second.

Where the Aurora Comes In

Here we have an explanation why the eruptive prominences rise so fast and so high—and also why they fade out, for when all the atoms are knocked to pieces, there is nothing left to shine. By the time this condition is reached, the density of the gas must be exceedingly low—according to Lindemann's estimate, about what one would get by allowing a six-inch cube of hydrogen as we ordinarily know it to expand into a cubic mile of vacuum. Even so, there would be more than a thousand million atoms in every cubic inch of it; but the atoms are so extremely small that they would very rarely hit one another.

We have now got a mass of entirely ionized hydrogen moving rapidly away from the sun. As it flies out into space it will gradually draw out into a long stream—since some of the atoms were moving faster than others when they stopped absorbing and shining; and it will also widen out a bit, since all the courses of all the atoms cannot be exactly parallel.

Lindemann figures that a mass of gas which, when it stopped shining, was 25,000 miles in diameter, and therefore would represent only a small part of an eruptive prominence such as has been frequently observed, would, by the time it reached the earth's distance, be a stream 600,000 miles wide and perhaps 50,000,000 miles long.

Suppose now that this stream intersected the earth's orbit, and that the earth happened to pass through it. As the fragments of the atoms hit our atmosphere, the electrons, which are light, would be stopped by the very first traces of air, while the positive nuclei, which are much smaller and heavier, would penetrate to a considerable depth. Thus the extreme outside regions of the atmosphere would be negatively charged, while a layer nearer the earth's surface would receive a positive charge. The recombination of the two would produce the electric currents which are needed to account for the magnetic storm, while the passage of the positively charged corpuscles through the outer atmosphere would set it shining, like gas in a vacuum tube, with an electric discharge, and produce the aurora.

There are still some puzzling details about the theory; but in its main outlines it appears to be as reasonable as it is beautiful; and it may add to the appreciation even of so glorious a spectacle as the Aurora if we believe that the flickering patches of light which wave in the sky are caused by the bombardment of the earth by the tattered fragments of some great eruptive prominence which was driven out

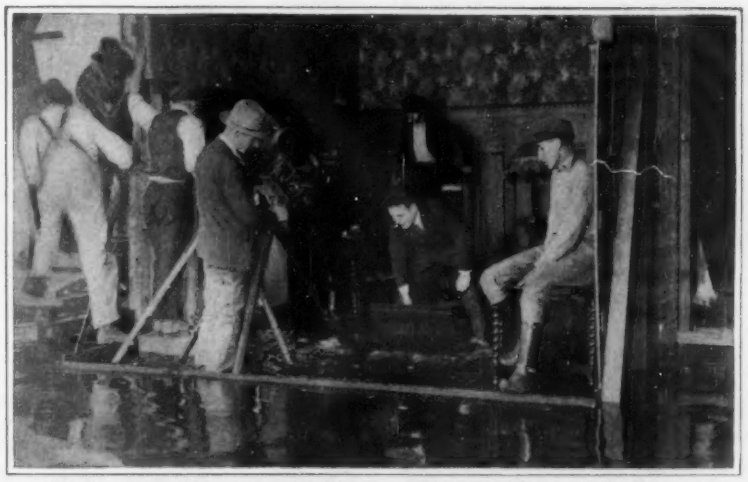
(*Continued on page 122*)

Rising Waters in the Films

WHEN the villain, in the melodrama, gnashes his teeth, twirls his mustache, and exhales a particularly melodramatic puff of smoke from his cigarette, while he hisses—villains always hiss—to the heroine: "The waters are rising; choose between me and a terrible end!" he may mean, not that the waters are rising, but that the floor is merely sinking. At least, that is the way it worked in a recent motion picture production, when there was occasion to stage a scene somewhat on the order of the one just suggested.

The action called for the hero and heroine to face drowning in a room which fills with water as the river breaks over its banks and inundates the surrounding country. The scene was staged by building the room in the middle of a large tank of water. A platform was extended forward from the open side of the room, and on it the photographer was stationed with his machine. At the signal, carpenters on the side-lines and outside the field of the camera, let the room down into the water.

Our picture shows the inundation about to occur, while the hero opens a trap door in the floor to discover whether there is any prospect of escape in that direction. The camera man is protected against the rising water by hip boots, while the property men, who are not in the picture but whose presence is necessary, take refuge on temporary islands provided by the chairs and other furniture.



Staging a moving picture flood by lowering the set into a tank of water

The Elephant's Toothache

JULIE is one of the huge pachyderms that perform daily for the edification of the audiences at New York's Hippodrome. Some time ago Julie came down with the toothache. The management was at first inclined to let the offending molar take the natural course; but Julie kicked up such a fuss about it that this was out of the question. For weeks she made day and night hideous with her cries; and when at length in her frenzied rocking she began to threaten the safety of the floor, it was found necessary to do something about the tooth.

Filling an elephant's tooth, however, is not a job for the ordinary tooth-doctor; it resembles rather the operation with concrete and steel bars upon a big tree. The animal dentist who was called in to deal with Julie's affliction found that her cavity was of very moderate size—it would only require fourteen ounces of filling! Our photograph shows the process of driving the filling home, and makes it clear that a crowbar is an essential feature of the zoölogist's dental equipment.

Curing the elephant's toothache with 14 ounces of filling

The Life-Gun with Water-Proof Charge

IN a series of recent tests made for the United States Steamboat Inspecting Board, the new life-line gun shown in our cover this week met every one of the requirements established by the Board and greatly exceeded the great majority of them. Unlike most of the guns now in use at life saving stations and on ship board, this one requires no separate powder charge, wad or primer. The charge and projectile are one piece, thus eliminating the danger of moisture getting to the powder.

In one of the tests recently made the cartridge case was immersed in water and then put into the gun and fired. In another, the barrel of the gun was filled with water, the cartridge inserted and successfully fired through the water, proving that any amount of moisture could not damage the cartridge or mechanism in any way. In none of the tests to which the gun was put was there a misfire or short shot. In every case the projectile went well beyond the mark, and did this without the breaking of a single line.

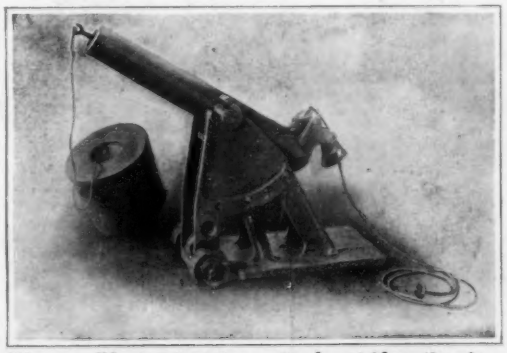
The one big feature of this new gun is, that it uses one-piece ammunition—powder and projectile in one. Contrast this with the present type guns which must be loaded with the powder charge and wads rammed into the barrel—much the same as the old-fashioned muzzle loaders. In case of a misfire, great time is lost in preparing the gun for a new charge.

The recoil was found to be perceptibly less than any other gun of like character. The teeth on the bottom of the gun carriage held the gun firmly in place during all of the tests.

The gun is made in two parts. The carriage and the barrel are so constructed that it can be easily and quickly moved from one part of the boat to another and the barrel can easily be carried by one man. The wheels in front of the carriage allow it to be moved easily in any position required. Tests were carried out at each of the gun's four elevations—30, 45, 60 and 80 degrees.

The Board's officials commented particularly on the simplicity of the gun and the ease with which anyone, even though unfamiliar with its operation, could handle it. Another point which came in for commendation was the length of the life line, which permits of accurate shooting at objects 1,700 feet distant.

When a cartridge is inserted in the barrel, the life line is attached to the projectile. A slight pull on the lanyard fires the cartridge and the line uncoils from its container without possibility of snarls or breakage.



The new life gun that fires a fixed cartridge, thus insuring against wetting of the powder

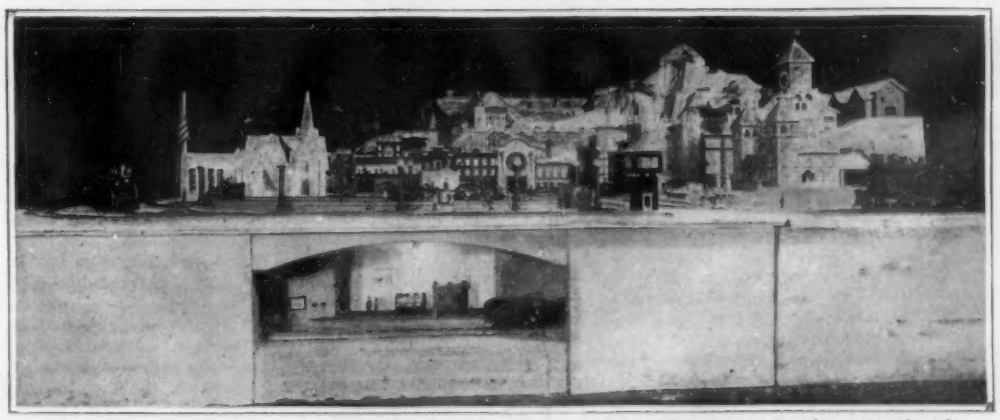
The Toy City

MECHANICAL toys get ever more and more complicated; and nothing could better illustrate this than the toy city on exhibition recently in New York. This city in miniature is complete to the last degree, showing all phases of the modern city, even to the subway service. And even the passage of time is represented by the changing lights—the illusion of daylight is here, the transition from sunset to dusk and to moonlight, the brilliantly lighted streets—and all aided by the sight of arriving and departing trains, moving taxicabs, automobiles and street cars. This is indeed an ensemble of action suggestive of busy urban life, and emphasizing that the toy, after all, is the precursor of the mechanical marvels of industry, and that to the plastic mind of the child the use of toys may mean a real training for the more serious business of life to come.

The toy city, including a surrounding canopy which provides the changing horizon where the lighting effects are staged for the passage from day to night, is 16 feet wide, 11½ feet deep, and 9 feet 8 inches high. A switchboard with more than 100 electrical connections through which the numerous parts of the city are operated takes up additional floor space of 19 x 25 inches.

This extraordinary city is very much "all there." Its business center shows stores of every description, from millinery to music, from fancy goods to drugs; it has its squads of mounted police and its traffic cops; its illuminated billboards and its theaters; its great city square with an electric fountain illuminated by changing lights; its police station and fire department; its skyscrapers and banks and public library; its great union depot; even a section of its subway appears beneath the city with green and red disks to signalize the arrival and departure of trains. And in the background rise the hills and distant mountains.

It must be understood that all features of this marvelous toy actually run. Express trains emerge from the tunnel and stop at the platforms in the union station, then rush on and disappear into the mountain side again. A train announcer performs his duty, and porters carry the luggage of passengers to and from the trains. Traffic flows through the streets; the fountain plays; with the fall of dusk the lights come on; every phase of the city life is faithfully reproduced.



A toy city, with street cars, steam railroads and a subway, all capable of operation from the electric system that lights the miniature houses

A Vegetable Manufacturer of Decorated Glass

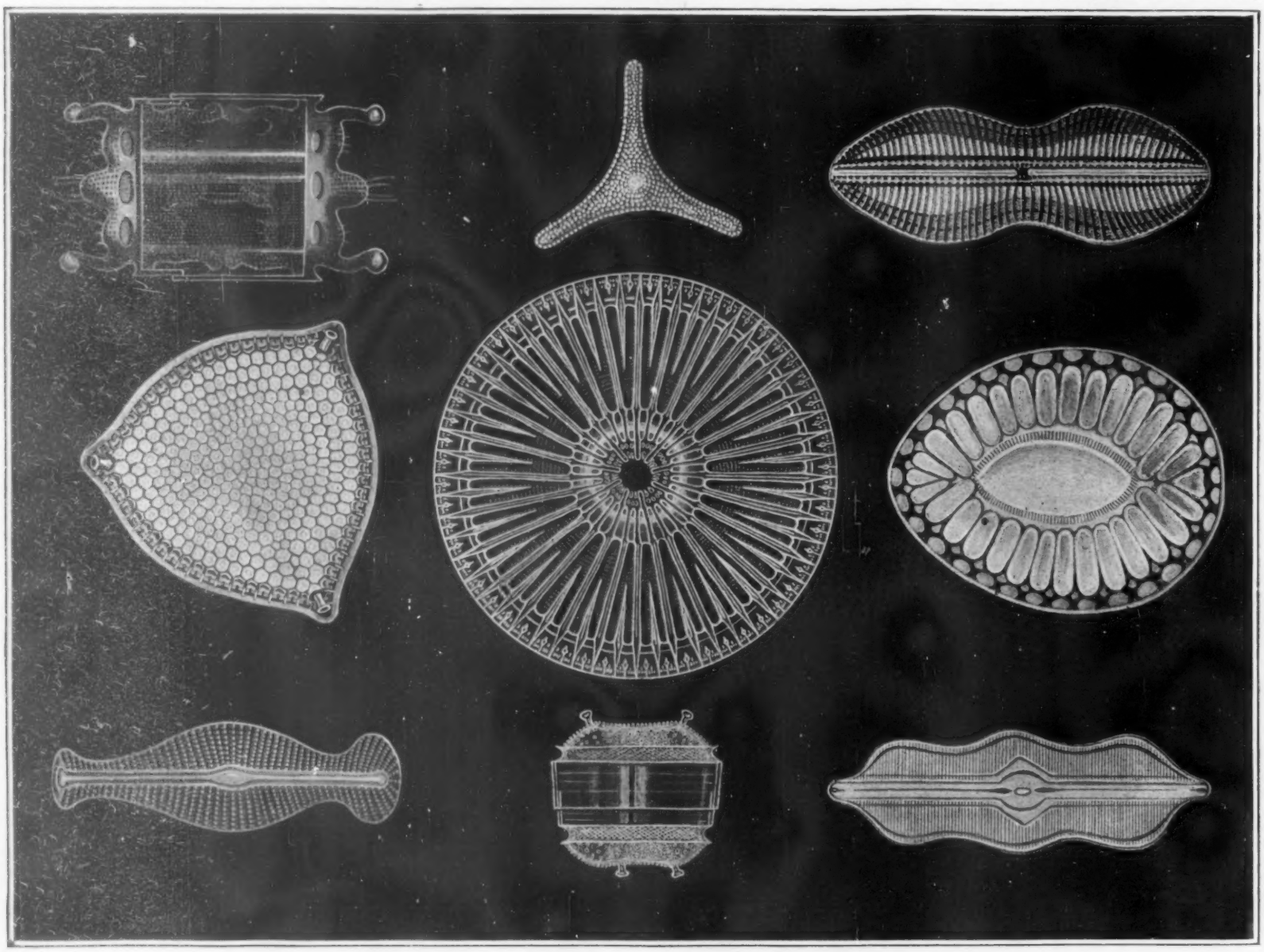
Some Remarkable Facts About the Diatoms Found in the So-Called Infusorial Earth

By William M. Butterfield

ONE morning, some years ago, Father Knickerbocker was startled by a rumor stating that one of New York's largest, most progressive baking companies was surreptitiously adding to its supply of flour by adulterating it with plaster of Paris. Of course the rumor was silly and totally impossible, yet many perverse citizens believed the accusation at the time and some believe it still. This credulity is not without some foundation however, for although plaster of Paris never has or ever can be used as food, there is a flaky, white earth of extreme lightness resembling plaster of Paris or a low grade of wheat flour, that has been used for centuries as an adulterant in baking. It is highly improbable any of our New York bakers case, the similar desire existing among some American Indians; or the poor white crackers of our southern states, who seemingly prefer clay at times to meat or vegetable diet. The physical effects of this earth appear to be similar to a powerful drug, wasting and enervating the body. Mountain Meal has been known, and probably eaten, for more than two thousand years, and although the consumption of it has had no far-reaching harmful effect, it is not an article for human food that can be safely recommended. So should some enterprising (?) baker suggest the use of this adulterant in the future, he should, in consideration of the above facts, be evicted from his baking industry as a safeguard to good health among our citizens.

agent against heat, cold and sound; as well as many other less consuming uses.

A German company situated on Lüneburg Heath in the northern part of that country has carried the cure and preparation of the earth to the highest perfection. Before the war this company imported into the United States considerable quantities of their product, where it was sold in competition with a somewhat less refined local product. The specific gravity of the German product is about 0.2 on an average, but when supplied in a levigated state the specific weight is often reduced to 0.13-0.15. The absorbing capacity of the latter is 80 to 85 per cent. The earth cannot be destroyed with acids or ordinary heat, and this light,



A group of typical diatom forms, of representative families; enlarged several hundred diameters

of prominence and respectability has thus far been forced by greed or lack of good grain flour to use this article. In parts of Europe, however, when flour is scarce, the poorer class of peasantry have often been known to add a considerable portion of this earth to their bread dough, for the supposed purpose of economy.

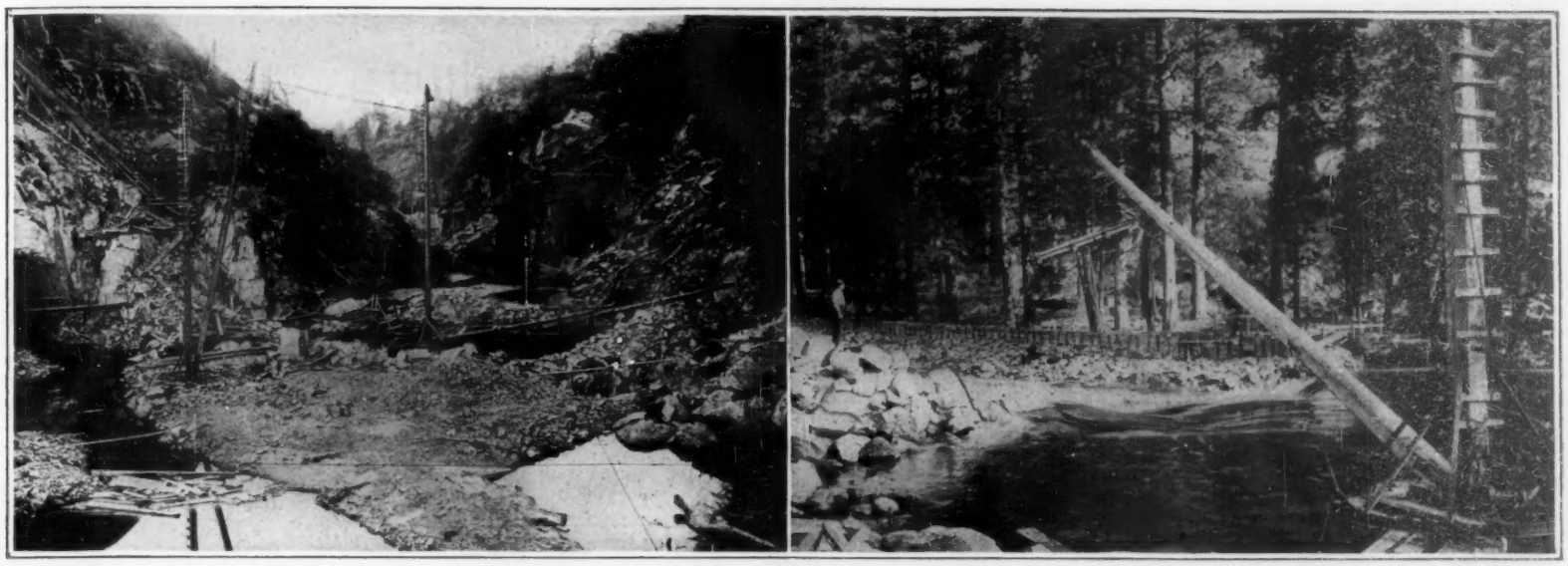
To such folk the earth is known as Mountain Meal, and its consumption is recognized by science as a form of the high sounding term cachexia. This habit of the peasant is not one of economy we see, for, to give a direct illustration, cachexia africana is a disease of the nutritive functions among negroes, which gives them an irresistible desire to eat dirt; or in another

Nor is the foregoing an idle illustration or an idle warning; for the mining of this flaky substance—distributed in huge fossil deposits of great areas and considerable thickness in every country in the world—has of late years been developed into a world-wide industry. It is now dried, carefully bleached, and calcined to a milky whiteness; and when pulverized it forms a flour not unlike, in look and feel, the first grades of wheat flour. Another thing advantageous to a possible misuse is its comparative cheapness and the ease with which it may be obtained. At present it is used in large quantities in making dynamite; for covering steam pipes; coating the outside of bake ovens; as a filling agent for paint and rubber; an insulating

smooth, water-absorbing material makes an ideal filler for many materials—providing none of them are intended to be used as human food.

The first important reference to the earth in history is found in a special record by Tacitus where he informs us that during the days of the Roman emperors artificial stone was made of the earth, which was so light that it floated on the Tiber. And now, in the present turbulent days of grace, we find an American company with offices in New York City actively undertaking the task of conveying mountains of this material from the California coast to any point specified by their patrons. We are further informed that other,

(*Continued on page 122*)



The temporary diversion dam, and the entrance (extreme left) to the unwatering tunnel — The drag hook, operated from derricks, used to keep the channel below the dam clear of rocks

Two of the interesting aspects of the Hetch Hetchy dam construction

The Hetch Hetchy Dam

THE Hetch Hetchy dam, which will cost the city of San Francisco over five million dollars, will be the biggest structure of its kind in California. It will be of cyclopean masonry, which consists of concrete with large boulders over a ton in weight deposited throughout the mass.

The dam will be 226½ feet in height above the stream bed, and the foundations will extend 75 feet to solid granite bedrock. The thickness of the dam at the crest will be 15 feet and at the lowest point in the foundation 320 feet. At stream bed there will be an offset in the foundation of 80 feet so that the dam can be raised an additional 100 feet in height without altering the foundation. The completed dam will impound a reservoir seven miles long and a mile wide. The present construction will impound 204,000 acre-feet or 66,000,000,000 gallons.

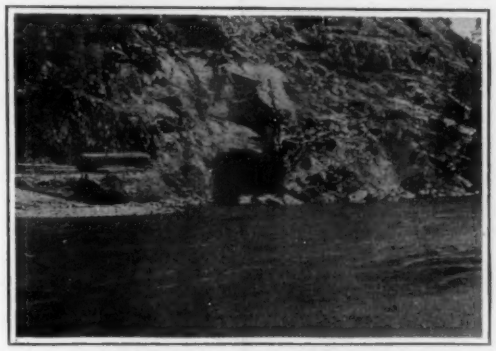
There will be 370,000 cubic yards of concrete in the contract, which was awarded. The length of the dam along the crest will be 600 feet and at stream bed 100 feet. In the river bed for the foundations 60,000 cubic yards of material must be excavated. All construction machinery will be operated by electric motors, current for which will be furnished from the temporary power plant erected by the city at the intake.

An interesting feature of this job is the drag hook and method of operating it in an effort to keep open a channel below the dam site. The hook is shown in our second photograph. It is dragged back and forth in the channel by cables manipulated by the three derricks shown in the picture. It is used for the purpose of dragging rocks from the channel. To the right can be seen a flume which is designed to carry this water during the dry season when the water is comparatively low.

The other two photographs illustrate the method of by-passing the stream flow to the Tuolumne River around the dam site during construction. At its lower end, Hetch Hetchy valley narrows to a gorge about 60 feet wide. For the purpose of by-passing the stream flow of the river during the excavation of the foundations for the dam and the construction of the dam proper, a tunnel was drifted at the dam site. This tunnel is shown in the small photograph. It is 23 feet in diameter. In its construction a portion of the spoil was saved for use in the concrete construction of the diversion dam. A diversion dam as shown in the first picture was constructed to divert the river flow into the diversion tunnel, above mentioned, for unwatering the main dam site.

British Rainfall Organization

AFTER having been maintained for sixty years as an unofficial enterprise, the British Rainfall Organization has just been taken over by the British Government. The annual, *British Rainfall*, will be continued, as will the monthly journal of the organization, *Symon's Meteorological Magazine*. Dr. Hugh Robert Mill, who has been director of the organization for 19 years, is retiring on account of impaired eyesight.

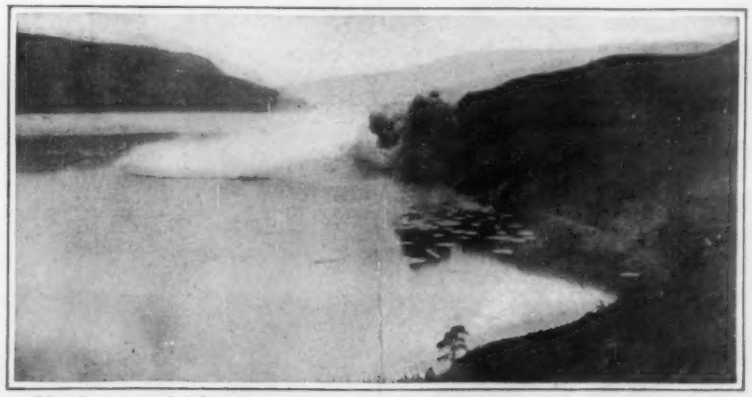


Portal of the unwatering tunnel

Beautifying the Service Station

THE filling station shown here is not the private property of a millionaire, as it would seem. It is a purely commercial station, which dispenses the elixir of life to automobiles and trucks. The average garage or service station is usually, alike in its architectural details and in its immediate surroundings, a good deal of an eyesore. But the illustration shows how even the most sordid of enterprises may be given an attractive appearance.—*S. Clay Roberts.*

The pump affords the only evidence that this is a service station, not a plutocrat's gatehouse



Blasting out a jutting promontory to make a short passage around the neck for the railroad tracks

Electrical Conductivity of Salt Vapors

ACCORDING to G. C. Schmidt, in *Mittcilungen des Reichsbundes Deutscher Technik*, the vapors or the volatile halogen salts of cadmium ammonium, zinc, ammonium, iron, and aluminum are good conductors of electricity even at relatively low temperatures, whereas the vapors of the halogen salts of mercury, tin, antimony, arsenic, and iodine, and organic substances are insulators.

The experiments show that the conductivity increases with time until a maximum is obtained and then falls to a constant value. Further tests, however, show that even at very high temperatures the conductivity of salt vapors is independent of time provided there is sufficient surface-constancy. The apparent inconstancy is caused by the fact that the vapors can only pass into the measuring chamber gradually, thus effecting a marked reduction in the surface and the rate of evaporation.

Making Way for a Railroad

THE building of a railway, especially in the mountains, entails much work of a spectacular nature. In the photograph attached is shown one phase of a large blast set off on a branch of the Canadian National Railways just building in British Columbia.

The blast was planned to remove practically all of the hundred foot rock point jutting out into Kalamalka Lake, near Vernon, B. C. Over twenty-seven tons of black powder were used, and the amount of rock removed was estimated at 40,000 cubic yards. Needless to say the shock was felt for some considerable distance and the wave created on the lake was over six feet high three miles away. Rocks flew several hundred yards from the seat of the explosion.

The branch line on which this work is being done extends from Kamloops, on the main transcontinental lines of the Canadian Pacific and Canadian National Railways, to the famous Okanagan Valley. This valley, in the heart of the Dry Belt of British Columbia, extends from the International Boundary near Oroville, Washington, over 150 miles north. Its climate is semi-arid, with long hot summers and short, mild winters, and this with the soil conditions makes it ideal for fruit raising. At present it is in a state of early development, but the output exceeds $5,000,000 in value already.

Considerable new country is opened by the new line being constructed, especially to the east of Lumby. Here are a number of converging valleys that will, with clearing, produce a large volume of food stuffs. While they are being cleared the railway will afford a market for the timber, which, up till now, has been too far from transportation to be merchantable. The tonnage contributed by the timber will go a long way toward paying the operating expenses of the line that taps it. The route adopted follows the watercourses closely, and there are a number of places, like that illustrated, where it is found cheaper to blow an entire promontory into the lake than it would be to cut across it or tunnel through it or run around it.—*G. P. Melrose.*

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

A New Form of Tire

THE object of the device herewith illustrated is to provide a non-puncturable tire and a means whereby badly-worn tires can be maintained in service long after they would ordinarily have to be thrown away. The device, which has been patented by Thomas C. McEwen, of Caldwell, N. J., consists of a series of half-round curved shields, united to form a complete ring, which is interposed between the inner tube and the outer shoe of the tire. This forms an inexpensive armor protecting the inner tube which is not liable to get out of order, and which does not materially interfere with the resiliency or cushioning effect as a whole. It is evident that this protection, interposed between the shoe and the inner tube, will safeguard the latter against punctures, blow-outs and other injuries. The formation of the armor in separate sections, easily linked up to form a complete ring, enables the owner quickly and conveniently to place the armor in position or to remove it from the tire whenever it is desired to change the shoe or the inner tube. Not only does this device protect a new tire, but by inserting it in a badly-worn tire it has been found in actual experience that the life of the shoe may be very greatly prolonged. In order to protect the inner tube from overheating and to cool the metallic armor, a series of air holes is formed around the shoe which serves to put the armor in contact with the outside air. Also, a series of tubes extending through the felloe and its rim, and opening into the shoe between the lips is provided for the same purpose. Dust and grit are prevented from entering these air vents by means of very fine metal gauze placed across such openings. It is claimed by the inventor that the compression of the tire when the machine is running exercises upon the inner tube a kind of pumping action which tends to ventilate the same and allow air which may have been entrained between the tube and shoe to escape.

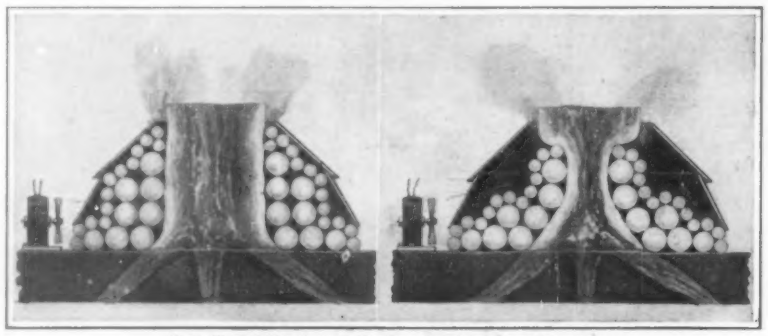
Visible Operation on the Sprinkler

THE operator of this motor sprinkler is protected by a heavy piece of steel which is bolted to the rear of the frame. There is considerable danger of automobiles striking the operator from the rear, and it is to guard the operator from injury that this metal guard has been devised. This enables the operator to give his entire attention to the operation of the sprinkler, when without this guard it would be necessary for him to give some attention to his own safety. A speaking tube has also been installed, which enables the operator to give orders to the truck driver.—*C. W. Geiger.*

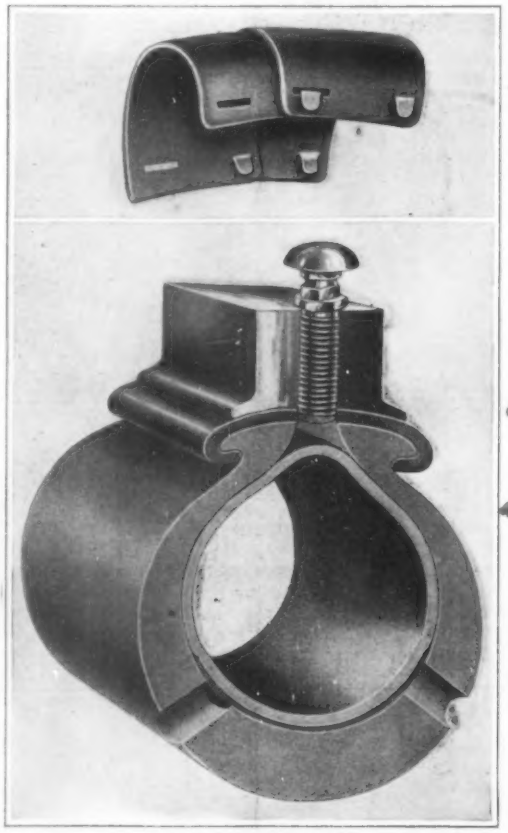
A Rapid Stump-Burner

THE old method devised by the Indians for removing stumps by fire may yet become popular if the recent successful experiments should prove readily applicable on a large scale, and according to experts the larger the scale the more economical is the process.

The sprinkler that carries a second man to regulate the water from the point of vantage shown



Details of the latest device for burning stumps



An armor-protected tire

The method consists in packing about the stumps spherical heat retainers, which are preferably made of burnt clay, although iron and other substances have been used successfully. A casing made of overlapping sections incloses the heat retainers and acts as a flue. At the commencement of the process, the general arrangement is that shown in the left-hand view. Any suitable burner may be used, and a comparatively small one is quite effective, for the reason that the stump itself forms a large proportion of the fuel.

At the right is shown the way in which the heat retainers move inward during the process of burning the stump. This movement is entirely automatic and is due to gravity, the spherical shape of the heat retainers aiding in the motion. They may be of two or more sizes, and when such is the case the smaller ones are usually placed outermost.

Where large numbers of stumps are to be removed, an elaborate preparation will prove economical. An electric fan can be used to advantage to create draft and make the fire more effective. Current for the fan can be produced with a small dynamo, run by a gasoline engine if desired. With such an equipment, a great many stumps can be burned at once and the work greatly expedited.

In some sections of the country the subject of clearing ground has assumed the importance of the pioneer days. Some of the cut-out timber lands can be cleared and used for agricultural purposes, and action in the matter hinges only upon what constitutes the most inexpensive process. Formerly, stumps were left in the ground to rot, but with land continually becoming scarcer the old method will be discarded.—*H. C. Ridgeley.*

Mosquito Survey by Airplane

AT first glance, one wouldn't say that airplanes bore much relation to mosquitoes. But they can be made to, and have been made to, up in the Fraser Valley of British Columbia, where there are great areas of low-lying land, undeveloped and ill-drained. Mosquitoes have become a great pest in this region, seriously reducing milk production. The Dominion Government accordingly stationed an expert entomologist there last spring to make a survey on which effective control measures could be based.

Here was where the airplane entered. Eric Hearle, the Government entomologist, had spent days in slow compilation of his mosquito map, a device to show the location of breeding places. He had toiled through marshes, and from mountain tops, with glasses, had taken observations. Then he thought of the airplane.

Aerial observation proved to be the ideal method. "In ten minutes aloft," declared the Government entomologist, "I made more progress with my map than I had in weeks on the ground." Mr. Hearle took a big map up with him in the airplane, piloted by Lieut. Trim, a war veteran, and as mosquito breeding places were located indicated their position on the map.

British Columbia, by the way, intends to use hydroplanes to perform another important function. Her forests are the most extensive and valuable in Canada, and they cover an undeveloped empire of thousands of square miles. It is proposed to use a hydroplane patrol system during periods of fire danger. Hydroplanes are preferred to land machines in order that inland ponds and lakes may be used as landing places.

The All-Way Street Sign

THE accompanying photos show an improved method of installing street signs, which permits both signs to be seen from all directions. The street names are painted on metal signs which are supported on a metal arm. This metal arm extends out over the sidewalk at such an angle that the signs are held in such a manner that both signs can be seen from all directions.

One of the signs is supported above the arm and the other is supported below the arm. A desirable feature of this method of installing street signs is the fact that the clamp that holds the names is adjustable, enabling the signs to be supported at any angle. Many street crossings are not exactly right angles, and in such cases the clamp may be adjusted to conform with any angle other than a right angle. The accompanying drawing shows how the signs may be adjusted to conform to other than right angles.

Street sign that can be seen with equal facility from all directions

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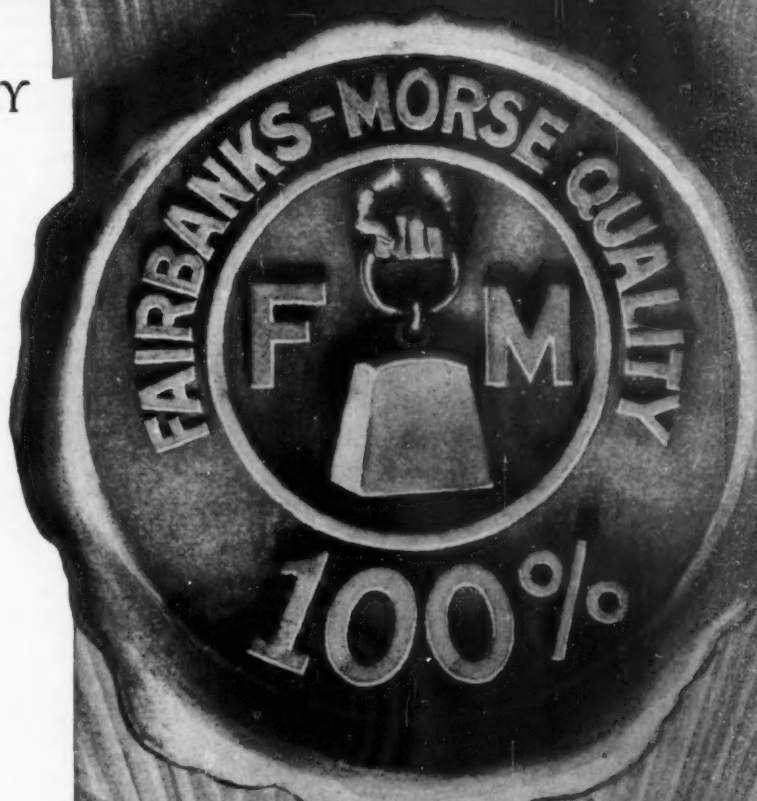

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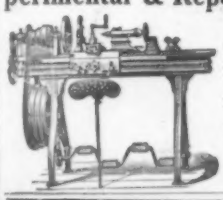

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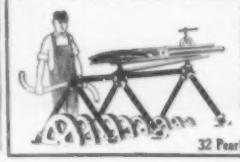

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The Naturalist's Corner

Wild Life Conservation All Over the World

By Dr. William T. Hornaday, Director New York Zoological Society

The Hoop Snake, and Others.—The hoop snake will not down. It begins to look as if he will be with us always. Once more we publish the news that the hoop snake does not hoop, that there is no hoop snake and there never was one. And no snake man, or naturalist, ever saw a snake swallow its young. Furthermore, no horsehair ever turned into a worm; but there is a thread worm that looks enough like a horsehair to be one.

Animal Mind and Thought.—There are even yet a few persons who think that dogs, apes, monkeys, horses, elephants and other lower animals have no minds, and "do not think." Without exception all such persons whom we know are among those who never have intimately associated with and worked with animals. Occasionally a man who does not know animals must be excused for not knowing (1) that they have minds, (2) that they think, (3) that some of them reason from cause to conclusion, and (4) that some animals have better minds than some men. And when all has been said, it is our judgment that the most interesting thing about a mammal is what it thinks, and what it does as the result of its reasoning.

Possible Exploitation of the Musk-Ox.—The ever alert and wide-awake Canadian Government is seriously considering the proposition made to it by Arctic Explorer Steffanson that the musk-ox and caribou of the barren grounds of northern Canada be colonized within easy reach of the haunts of man, and utilized as regular sources of food. The possibilities in the musk-ox are receiving first consideration, and in response to an invitation from the Canadian Government, the Director of the Zoölogical Park has given information and opinions derived from twelve years of daily experience with captive animals. The questions being considered relate to the control of herds of semi-wild animals to prevent their wandering away, their protection from wolves and the possibility of survival in winter in strange territory without artificial food supplies. The edibility of musk-ox meat is no longer open to argument. Thus far, although there should have been breeding in the musk-ox herd that lived nearly seven years in the Zoölogical Park at New York, no calves were born.

The Snake Market.—We think often of the saying of the French—"Cést la guerre!" And "it is the war" that has removed the bottom from the snake market of the world. At this moment it seems as if everyone wants big snakes, with no offerings in the snake market. So far as observed, not one really large snake, either python, anaconda or boa, has entered the port of New York in four years. The reason has been that shipping facilities have been totally denied—until now. Two months ago the New York Zoölogical Society received a big-snake cable from Calcutta, and for a time it was thought that the spell was broken. The snake in Singapore was ordered, but later on it was discovered that it had not yet been caught. And still it is flowing in freedom through the reeking jungles of the Malay Peninsula, seeking what wild pigs and domestic goats it may properly devour. One other trouble has been the preoccupation of the regular snake catchers of the tropics. Really large anacondas, even of 17 feet, have become a dim memory, and even war prices fail to produce them. Today the question is: when will we see the end of the snake famine?

The Film Expedition to Africa.—One of the most ambitious moving picture enterprises that ever undertook Africa very recently has landed at Cape Town to take the long trail northward. It is wholly in command of the veteran naturalist-explorer, Edmund Heller, who represents the Smithsonian Institution's interest in the animal collections to be made. Possibly the party is at this moment in the throes of an effort to get "the last films of the elephants of the Addo Bush Forest Reserve," before that troublesome herd is blotted out by the pressure of civilization. The filming expedition will work its way northward through Rhodesia, where comparatively little big game now remains; it will take the Falls of the Zambesi, the game of Nyassaland, and it will break new ground for the movies in what once was German East Africa. If it secures a few thousand feet of the Uganda giraffe it will do the public a good turn; for that species never yet has been filmed. Beyond German East Africa there lies a bewildering maze of opportunities, and we may be sure that Mr. Heller will choose the best ones. We welcome the prospect of more African wild life, great and small, but we shrink from the prospect of untold thousands of feet of monotonous African blacks. Beyond doubt the expedition will secure great pictures, and a great collection of animal specimens for the United States National Museum.

Practical Zoology in the University of California.—On this day and hour of great demand for practical zoölogy, of the kind that is of real use to man, the annual output of the University of California is worthy both of praise and emulation. The Museum of Vertebrate Zoölogy of that institution is a center of highly interesting activities, and it is producing a line of zoölogical publications of which President Benjamin Ide Wheeler has every reason to be proud. The wide awake and progressive scientific spirit, and the sound, common sense of the U. of C. are beyond all ordinary terms of praise. Dr. Joseph Grinnell, the chief investigator of California mammals and birds, has the happy faculty of choosing live subjects, and publishing the things that the public most desires and needs to know.

The admirable 116-page popular scientific monograph "The Ground Squirrels of California," by Joseph Grinnell and Joseph Dixon, is one of the latest and best examples of the output of the University Museum. Really, it is a model of how such things should be done. The scientific basis and the key to species is all there: geographical distribution is shown by good maps; there are diagrams of underground works, and economic facts and figures galore. Finally, the wealth of well-chosen illustration in beautiful colored plates and in black-and-whites, leaves nothing more to be desired—save some specimens of the most representative living animals for the New York Zoölogical Park!

Useless Scientific Publications.—In these days of scarce money for printing and high bills for paper, it is surprising to observe the number and wide geographical distribution of perfectly useless scientific publications. From the "scientific centers" of the world's great capitals to the most remote circumferences of civilization, and sometimes from unknown regions, there pour forth over the world continuous streams of pamphlets thick and pamphlets thin, often illustrated by the most grotesque and outlandish figures imaginable, intended to elucidate the

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The Gray Wolf as Stockman's Pest.—Mr. Bud Dalrymple, wolf catcher extraordinary, of Scenic, South Dakota, has written, and Mr. Henry W. Shoemaker has published for him, an extremely interesting illustrated pamphlet of about 50 pages on the pestiferous "Gray Wolf of South Dakota." Bud has been a professional wolfer for twelve years, and this means that he knows the game, and has made good. One of the strange items of mammalian lore is the persistence of the big gray wolf in refusing to be exterminated. We know that he can to quite an extent be put down, but in the thinly populated cattle country of the West it seems wellnigh impossible to keep him down. He is strong, hardy, a good traveller, bold, cunning, prolific and resourceful; and going or coming, he loves calves, colts, heifers, young and inexperienced steers and sheep of all brands. He is the only four-footed creature that constitutes a real scourge to the western stock-growing industry, and even today in some states his annual intake is appalling. Mr. Dalrymple's discourse on trail baits, dens, pups, wolf habits, and even the wolfer's outfit should cause next year a rise in the figures of wolves destroyed in the cattle-growing states. His directions telling how to crawl into a she-wolf's den when the housekeeper is present, and the desirability of putting her cubs alive in a bag, is delightful. The picture of the author's "Hides sold for 150," looks like a ruinous bargain counter. If this booklet does not induce some of our successful Hun-hunters to become wolfers, nothing ever will. It is to be obtained of the Altona, Pa., *Tribune*.

The Quail Supply from Mexico.—It is now about ten years since every American state placed the grand taboo on the exporting of live quail, no matter what the demand or the purpose. The once great quail business of Oklahoma one day ended with a resounding crash. Then the "No Quail" signs went up everywhere. But the demand for quail continued, just the same. Sportsmen who had joyously and with devilish persistence exterminated their state quail, begged their state game commissioners for "more quail, for restocking purposes." Those of us who long have begged for a square deal for Bob White endured this situation with grim resignation, and some spitefully said: "It serves you right!" Since the American lid was clamped down, the quail dealers have relied upon northeastern Mexico as their best and only source of supply. Even though the transplantation of hot-country quail to the cold North and to adverse conditions generally, gives only one chance in ten of success, it is astonishing to note how extensively that gambler's chance has been taken. Dr. Frank Kent, a wholesale quail dealer of San Antonio, Texas, states that in the sea-

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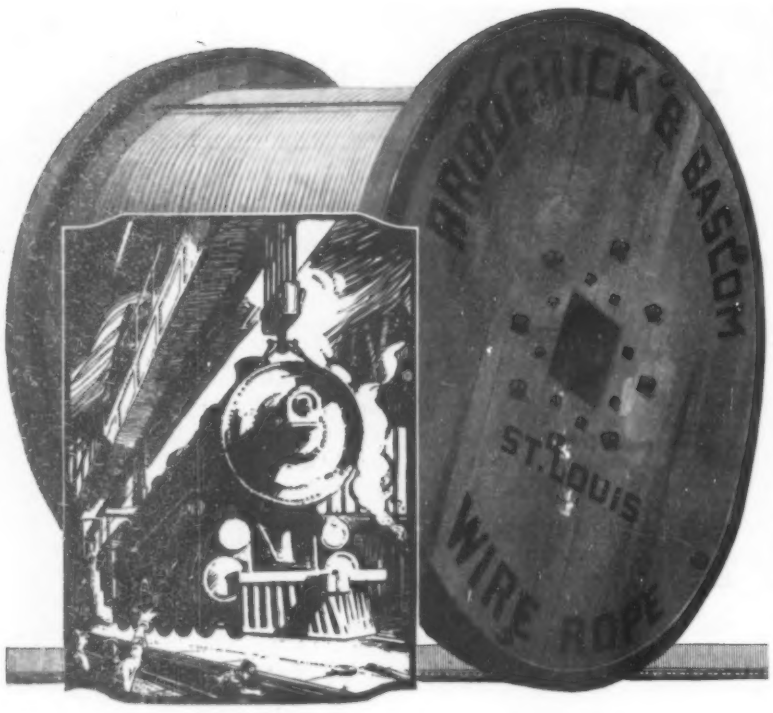

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son of 1915-16 he imported over 8,000 quail and in the following season 35,000 All these were trapped within 50 miles of Eagle Pass. After 1917 the long and severe drought seemingly caused the Bob White quail to migrate from their old haunts, and their scarcity reduced his quail catch for the past year about 75 per cent. Then efforts were made in the vicinity of Tampico, but with such slender results that Dr. Kent woefully reports $5,000 as the cost to him of 500 quail. On the whole our desolated quail states are yet a long way from being permanently restocked with Mexican quail.

Mountain-Peak Grazing

(*Continued from page 108*)

barley and oats. Closely associated with the grasses are the so-called sedges and rushes, plentiful in meadows and more moist situations. Above timber line we have a stunted growth of grasses and sedges but these are invaluable as feed and are much sought after by stockmen, because of their succulent nature. In other words they are green longer than the feed growing at the lower altitudes and are fresh at a particularly favorable time of year. Among the "weeds" are the various wild clovers; fireweed, which is excellent sheep feed; different members of the legume family such as the wild pea and vetch, and numerous flowering plants —all or nearly all of which are choice feed for sheep. In some sections grasses and weeds are scarce and stock eat so-called browse, which oftentimes is as valuable as herbaceous vegetation. Among the most valuable browses are scrub oak, deerbrush or mountain lilac, service berry, wild rose, willows, etc.

It is a wonderful experience for the sheep in midsummer up above timber line —and for the herder as well; literally on top of the world in the most magnificent scenery out of doors, rushing cataracts thundering on every hand, marvelous wild flowers, rocks and ledges and canyons and slides and perpetual snow banks with a magnificent rarified atmosphere. Here in forage belly deep the sheep revel without annoying flies or heat and sure of fresh water in plenty. The snow barely gets off so they can move in by July first and gradually up they go clear to the peaks, 14,000 feet high; then back again, driven down by the snow, and finally out of the higher range by September first. It is a great life. It was indeed wise forethought that threw open the higher altitudes to the sheep grazing where with little expense the lambs are fattened for the market and come down in autumn to top the markets.

The New York State Barge Canal—IV

(*Continued from page 112*)

cels—the rail service, and the achievement illustrates, in some measure, the possibilities of the new system. The steamer "Douglass" is of the so-called "old canal" type, 98 feet in length, 17 feet beam and has been in service on the canal for a considerable number of years. No attempt was made on the trip in question to establish a record and the steamer merely proceeded steadily at an average speed of better than 4 miles per hour.

State authorities do not expect an immediate development of commerce on the new waterway. In the same manner that traffic on the old Erie Canal started at a low level and gradually increased from year to year until the peak was reached in 1872, they anticipate a gradual restoration of traffic to the Barge Canal. A beginning has been made during the 1919 season, a small beginning it is true, but indicative of a growing sense of the value and importance of the system in the minds of shippers generally. But one thing remains to be done. Shippers must be convinced that the waterway is not only an efficient and economical means of transportation but that it offers moreover a profitable field for investment. When this frame of mind has been reached, and when big navigation companies, financed by those who will benefit by the service such companies will render, place modern barges in operation, then the New York State Canal System may be said to have come into its own.

The Heavens in February, 1920

(*Continued from page 114*)

from the sun some two or three days before.

The Heavens

The southwestern sky is very fine. Castor and Pollux are near the zenith. Below them, to the south, is Procyon, and then the brilliant Sirius. More to the right is Orion, perhaps the most distinctive in form to the amateur star-gazer of all the constellations, with the two bright stars Betelguese and Rigel; and again to the right is Aldebaran, almost due west. In the northwest the bright star high up is Capella. Below it is Perseus, then Andromeda, partly set. Cepheus and Cassiopeia are low in the north, with Draco and Ursa Minor in the northeast, while Ursa Major is high above the latter.

Arcturus and Spica have just risen, north and south of east. Regulus is high in the southeast. Jupiter and Saturn, which are both in Leo, add greatly to the brightness of this region. Further to the right is Hydra, standing bolt upright on its tail, and extending far toward the zenith.

The Planets

Mercury is in superior conjunction, behind the sun, on the 5th, and is therefore invisible until well toward the end of the month, when he is well placed for observation, setting at 6:15 P. M. Venus is a morning star in Sagittarius and Capricornus, rising about 5 A. M.

Mars is in the eastern part of Virgo, and rises at 11:50 P. M. on the 1st, and 10:30 on the 29th. He is steadily approaching us, and by the end of the month is as bright as Capella. Jupiter is in opposition on the 2nd, and is conspicuous all night long. He is on the boundary between Cancer and Leo, and much outshines any of the stars, being twice as bright as Sirius.

Saturn, too, is in Leo, farther east than Jupiter, and is in opposition on the 28th. His rings are seen more nearly edgewise than at any time during the past twelve years, and in consequence he appears fainter than formerly and only about equal to Procyon.

Uranus is in conjunction with the sun on the 21st, and is invisible. Neptune is in Cancer, just past opposition, and is visible teleseopically—his place on the 1st being $8^h\ 50^m\ 17^s$, $+\ 17°\ 41'$; and on the 29th, $8^h\ 47^m\ 17^s$, $+\ 17°\ 54'$.

The moon is full at 3 A. M. on the 4th, in her last quarter at 4 P. M. on the 11th, new at 5 P. M. on the 19th, and in her first quarter at 7 P. M. on the 26th. She is nearest the earth on the 1st, and again on the 28th, and farthest away on the 13th. During the month she passes near Neptune on the 3rd, Jupiter on the 4th, Saturn on the 6th, Mars on the 10th, Venus on the 16th, Uranus on the 19th, and Mercury on the 20th.

Princeton University Observatory,
1920, January 17.

A Vegetable Manufacturer of Decorated Glass

(*Continued from page 116*)

as yet untouched, mountains await the same fate in Mexico, South America, Canada and other American points. Of any dealer selling paint fillers, chalks, fullers-earth and such like materials and adulterants, the earth may be obtained under the name of infusorial earth. It ranges according to quality, from a pure white to yellow or chocolate, and might be taken for powdered chalk or clay.

Indeed it is thought to be a kind of clay; and this is not remarkable for the

common definition of clay is very elastic, embracing every kind of mineral substance possessing the qualities for coloring water with tiny floculent particles, or for forming dough-like deposits or slaty stone. Infusorial earth, so called, has these qualities and can be easily mistaken for clay. It is not, however, an infusorial earth, first, because the particles which compose the mass are not infusoria; secondly, because it is not an earth in the true definition of that term; therefore it is not clay. Each particle is composed of pure silicic acid, a natural glass, and is of organic origin—that is, formed by living organisms.

To clay eaters and commercial exploiters this fact seems until recent times to have been of slight importance. The more up-to-date exploiter is very much awake to the importance of these organic particles in making the mass absorbent or light. They are also aware of the differences, which is only too plainly evident in the various deposits, caused by a more or less perfect segregation by natural causes of the species during development and deposition. It is a long cry from the days of the Roman emperors down to the minute of modern activity, yet the human race seems to have been actively employed in the contemplation and use of these deposits during all the intervening space of time. But today, right at this minute, only a very, very few of the thousands of workers who handle the material daily know that it is at all different from any other common "dirt" of the fields. These fossilized atoms belong to an invisible world that can only be entered with the aid of the microscope.

The botanical name of these atom fossils is Diatoma, from two Greek words, meaning a cutting through. They are a genus of algae, the typical one of the order *Diatomaceae* and belong to the britterworts, an order of flowerless plants. Commonly the individual plant is known as a "diatom." The plants are aquatic, inhabiting both fresh, brackish and salt water. The living forms are so abundantly distributed that there is no body of water that does not contain them. The drinking water from the taps in our city kitchens contain diatoms, and certain species are responsible for disagreeable odors and tastes in this water at stated periods of the year. Daily examination with the microscope of our reservoir supplies is made for the purpose of curtailing their too abundant accumulation.

To examine the living diatom under the microscope it is only necessary to place a tiny drop of water on a glass slip when their brownish bodies of certain monoform species may be seen moving majestically across the field of vision. It is this power of movement in diatoms that has caused volumes of discussion to encumber the literature about them. At first they were thought to belong to the animal kingdom because of this faculty, and it is not yet decided satisfactorily how or why they do move. Other species are parasitic, attaching themselves singly or in groups to submerged algae; others attach themselves together in long ribbon-like filaments, while still others surround their colonies with mucous-like substances.

But if an anatomical examination is desired, it is necessary first to kill the diatoms in such a manner as not to distort any of their parts. They are then stained, and the ordinary processes of examination resorted to. As a result of this sort of examination a large amount of very valuable anatomical data has thus been given to science relating to a few of the species, but it is not necessary for us to review it here.

This preparation, of both the living and fossil forms, is accomplished with the aid of the most powerful acids as well as of other reagents, not counting filtration, sedimentation and a number of similar time-consuming and laborious details. With the amateur, cleaning is always uncertain; and while the expert professional often obtains fairly successful results he never can entirely remove "foreign matter" from the diatoms. To overcome this fault he resorts to separating them, while still unmounted, using the microscope and a "mechanical finger." When the diatoms are cleaned and segregated the professional mounts them singly or in groups—sometimes arranged in ornamental patterns—on a glass slip, finally cemented in place and covered with balsam and a protecting glass cover. This briefly represents the work which "diatomaniacs," as they are sometimes called, have given cheerfully and gladly to the so-called study of *diatomaceae*. And it may be said that there are as many "investigators" today—if indeed there are not more—than at any time this last hundred years.

Seen in this denuded state, the diatom, as the skeleton is still called, is found to consist of a top, bottom and rine, like a tiny glass box. The lower center figure on the illustration will show this formation admirably. The other figures shown will convey an idea of the variation in shape and size of different families and subfamilies. The species of one family do not as a usual thing differ as greatly as do these figures, but it is the markings or decorations which are more generally considered in defining a species or variety, not the shape. Each member of a species is supposed by most workers to be of about the same size, shape and have the same markings. This basis of determining has resulted in much confusion and in the increasing of the number of species.

Inadequate as these figures are to show the striking beauty of the diatom seen under the microscope, they at least show—in the most perfect manner yet attempted—something of the marvellous skill of this decorated-glass-making vegetable. And it is seen that a simple diatom from the mud of the Hudson may easily rival in decorative skill the harmonic pendulum, the geometric chuck, a bow-compass or any other human mechanical contrivance. Some of the greatest men of England, Europe and America have been skilled diatomists, large volumes have been written about them, and the highest art has been brought to bear upon their illustration—yet no picture as word-painting can compare to one peep through a good microscope.

It was the microscope that enabled the geologists in the early part of the last century to show that whole districts of Istria and Dalmatia consist of diatoms; that large tracts of Austria are almost exclusively composed of their fossil deposits; that they exist, less extensively perhaps, in fossil and living form on every heath and meadow in Europe and England. Even the hilltops and mountain uplands presented outcropping stratas for inspection, while their rills and streams afforded a harboring place for the living. Microscopic geology was born and became a fixed science during these exuberant, never-to-return, pioneer days. Rapacious for new worlds we see it moving over to America to identify the far-famed deposits of this continent. Perhaps the first deposits to receive attention were those of Nova Scotia, Canada and some of the eastern states. Then, about the middle of the century, a deposit eighteen feet thick under the city of Richmond was located. This deposit, and a small one found in the Barbadian radiolarian deposits in the West Indies about the same time, produce the most strikingly beautiful fossil diatoms known. They have the interesting peculiarity of possessing species that are found nowhere but in their particular locations, a now recognized truth of environmental influence on structural development in diatoms, not altogether accepted at the time of their discovery. Then come the artesian well deposits at Atlantic City, obtained in some instances a thousand or more feet beneath the surface of the earth, with their particular forms. Later the Santa Monica famed floating stone, full of rare

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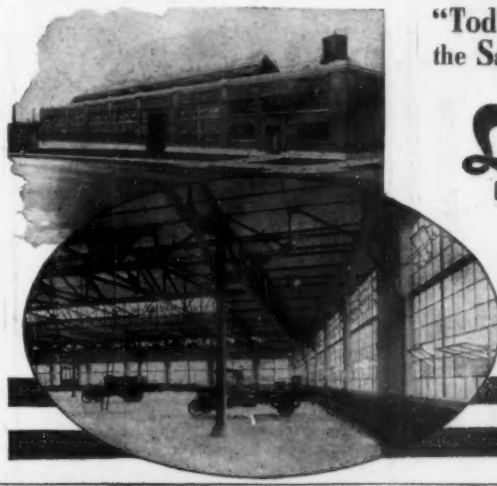

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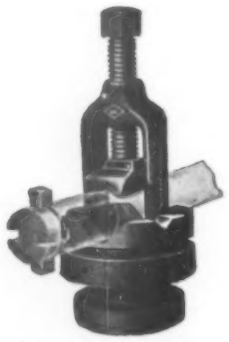

Why Use Makeshifts?

WHY waste time and energy with makeshift devices for boring operations when Williams' "Agrippa" Adjustable Boring-Tool Posts offer convenience and efficiency developed to the *n*th power.

Each Post accommodates a wide range of Bars, the height of which is readily adjusted; a turn of the Knurled Ring raises or lowers the base on which they rest. The whole device is instantly and rigidly locked by tightening the Set Screw.

Four sizes for ½" to 2¼" diameter Bars—furnished with or without Bars.

J. H. WILLIAMS & CO.
"The Drop-Forging People"

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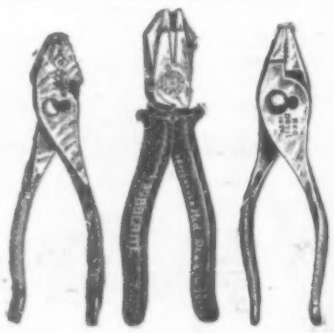

Working with Tools

Many a man would just as soon spend a day in the garage—working with tools—as on the road, driving along in the sunshine.

Even if he has no choice, if he has *good* tools the work will go smoothly—the time pass pleasantly.

"Red Devil" Pliers

are made for professional mechanics and electricians—and the amateur who appreciates good tools.

Drop forged tool steel throughout; strong enough for hammer, wrench, handvise, a multitude of different uses.

Write for Tool Booklet

SMITH & HEMENWAY CO., INC.
266 Broadway New York City

"The Red Devil" trade mark covers a complete line of hand tools for Mechanics and Electricians. "Red Devil" corrugated lock washers have 6-point contact, and are particularly effective.

UND. LAB. INSPECTED

ECONOMY
Renewable
FUSES

Mean Double Protection

ECONOMY renewable FUSES were approved—IN ALL CAPACITIES—by the Underwriters' Laboratories on Dec. 9, 1919—the old "APPROVED IN ALL CAPACITIES" renewable fuse using an inexpensive bare link to restore a blown fuse to its origiual efficiency.

There were millions of Economy Fuses in use before this approval was granted—a fact applicable to no other electrical device listed in the code as requiring approval.

The use of ECONOMY renewable FUSES means double protection—the dependability of the fuse itself—the regular inspection by the Underwriters' Laboratories.

Approved In All Capacities

Economy Fuses, approved in all capacities, ferrule and knife blade types, are stocked and sold by all leading electrical dealers and jobbers in the United States and Canada.

ECONOMY FUSE & MFG. CO.
CHICAGO Branches in All Principal Cities U. S. A.
Economy Fuses Are Also Made in Canada at Montreal

forms; the Boston Basin deposit; then Santa Barbara; Wilmont, Va.; Portland, Ore.; Fitsgarlolo Lake, N. B.; and so on until we find the whole North American continent stratified with deposits of diatoms. And so it is everywhere in the world, at the bottom of the oceans and the great inland lakes.

In the spring a brownish scum forms on all quiet bodies of water, even the ice of the oceans; the lakes and the streams are stained a rusty yellow with the accumulating moss. This substance is composed of millions upon millions of diatoms preparing for another year of world conquest. Soon every wet or moist spot is covered with more or less abundant calories. It is natural to suppose that this visible demonstration of diatoms represents in any locality the major part of the living habitants, yet the scum is not over one hundredth part of an inch in thickness, forming a mere film easily washed away or disintegrated. Removing the vegetable substance from the glass box of each diatom, this box could not take up more than one two-hundredth part of an inch in a fossil deposit. Providing, therefore, such boxes were deposited one on top of the other it would take 43,200 to make a monolith as high as the eighteen feet of fossil diatoms under the city of Richmond. As the diameter of the largest diatom of that deposit is not over one-hundredth part of an inch, one may arrive at an understanding of the effort of thinking power required to comprehend the incalculable numbers of diatoms that the deposit contains or the enormous periods of time required to form it. Particularly when we are assured that formations of this kind are reduced to at most one-third of the calculated size by erosion and other natural destructive forces, and, further, these calculations are with the largest diatoms which are as a usual thing comparatively few in all deposits.

Electrolytic Destruction of Steel Due to Leakage from Electric Railroads

ELECTROLYTIC destruction of water mains, gas mains and foundations of steel buildings, due to leakage from electric railroads, has always been an important problem of the steel industry; and the Bureau of Standards has prepared for publication Technological Paper No. 127, by E. R. Shepard, giving the results of more than three years of measurements of the electrical resistance of the different types of road beds. This has been done particularly with reference to the possibility of safeguarding underground steel against the leakage from electric railroad systems.

Short sections of 14 common types of roadbeds were constructed on the grounds of the Bureau of Standards, and resistance measurements under varying weather conditions were carried on for three years. Some measurements were also made on a number of city lines in and about Washington, both open track and several types of roadbed in paved streets being investigated. Through the coöperation of the United State Forest Products Laboratory measurements were also made on several sections of test track on the Chicago, Milwaukee and St. Paul, where railroad ties subjected to several kinds of preservatives were employed. The results of these measurements are given in tabular and graphic form, and the following conclusions have been drawn:

Roadbeds constructed with solid concrete ballast and vitrified brick, or other non-porous pavement, have a low leakage resistance to earth which is affected only moderately by seasonal and other changes. There is little difference between the wood and steel ties in their effect on the resistance of roadbeds of this kind. Roadbeds constructed with a foundation of clean crushed stone under a concrete paving base have a much higher resistance than roadbeds with a solid concrete ballast. In the case of the experimental roadbed the ratio was found to be about 3 to 1.

The resistance of earth roadbed in which the ties are embedded and therefore kept in moist condition is much lower than that of open construction roadbed. The resistance of roadbeds of open construction is subject to wide variation, depending upon the condition of the ties and ballast. Cinder, gravel, and particularly crushed stone, when used as ballast in open track construction, produce very high-resistance roadbeds. Earth has a tendency to keep the ties moist and therefore to increase the leakage. Open construction track is often considered to be insulated from the earth, but this is not strictly true.

Meters for Measuring Steam

METERS for indicating or recording the amount of steam that is being generated by a boiler or a battery of boilers or is passing along a steam main are being put on the market by a British Company. These appliances are based on the law that the rate of flow of steam through a constriction in a steam main is approximately proportional to the square root of the difference of pressure across it if the pressure and superheat of the steam are kept constant, or to the square root of the product of the difference of pressure and density of the steam if the pressure and superheat vary.

They consist of three main parts: (1) The orifice carrier, which carries an orifice plate and is inserted between two flanges on the steam main; (2) the cooling chambers, which are attached to the orifice carrier by carrying bars, and in which the steam condenses, so that the pressure pipes and the indicator or recorder is always filled with water; and (3) the indicator or recorder, operated in the case of non-pressure-corrected meters by the difference of pressure across the orifice, or with pressure-corrected meters by the product of the difference of pressure across the orifice and the absolute pressure of the steam, which is approximately proportional to its density.

The indicators and recorders are made in three forms. The rate-of-flow indicator, by measuring the difference of pressure across the orifice shows the amount of steam passing at any instant, uncorrected for variations in the pressure or superheat, and its dial may be graduated to indicate pounds of steam per hour or other desired units at a predetermined pressure and degree of superheat.

The diagram steam-flow indicators, as they are called, which may be furnished with a mechanism that automatically corrects for variations in the steam pressure, draw a daily or weekly record; while a third type is obtained by combining with them a counting mechanism, consisting of a spindle rotated by clockwork once every two minutes, and a clutch which is thrown into gear at the beginning of each revolution and out of gear at a point corresponding to the quantity to be added to the counter reading. Provided that each orifice, or one exactly like it, is calibrated under conditions similar to those under which it will be installed, these meters are guaranteed to have an average accuracy, under working conditions with steady flows, varying from plus or minus 2 per cent at full and three-quarters load to 4 per cent at from one-quarter to one-eighth load. The instruments which do not have automatic pressure correction are supplied with a table of constants to enable their indications to be corrected for variations in the pressure, wetness, and superheat of the steam, while for those which do have such correction there are tables of correction for varying wetness or superheat.